Taxonomy of species deriving from the publication of *Eucalyptus* subseries *Cornutae* (Myrtaceae)

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Abstract

M.I.H. Brooker & S.D. Hopper. Taxonomy of species deriving from the publication of *Eucalyptus* subseries *Cornutae* (Myrtaceae). *Nuytsia* 14(3): 325–360 (2002). The *Eucalyptus* subseries *Cornutae* Benth. comprised, in 1867, seven species endemic to the southern part of Western Australia. Since that time many more taxa have been published and given association with the subseries. We have studied the diagnostic characters of the subseries, as based on *E. cornuta* Labill., and, consequently, maintain the numerous taxa that have affinity with this species and reject others that do not comply, e.g. *E. gomphocephala* DC. The main diagnostic feature of the subseries is the erect orientation of the stamens in bud, a character not seen outside of this group. All together, nine new species, two of which comprise two subspecies, and two new subspecies of previously published species are published in this study.

Some taxa traditionally given association with the *Cornutae*, e.g. *Eucalyptus cernua* Brooker & Hopper *sp. nov.* (formerly and incorrectly known as *E. nutans* F. Muell.) have been treated as a sister group based on leaf surface characters, but are distanced morphologically from the *Cornutae* by the stamens which are inflexed. In this respect, examination of the type of *E. vegrandis* L.A.S. Johnson & K.D. Hill reveals that the stamens are inflexed. Thus we reassign it to the species group that includes *E. cernua*.

Other new taxa published in this study are, *Eucalyptus* x *missilis* Brooker & Hopper (of probable hybrid origin), *E. arborella* Brooker & Hopper, *E. astringens* (Maiden) Maiden subsp. *redacta* Brooker & Hopper, *E. diminuta* Brooker & Hopper, *E. mequoidii* Brooker & Hopper, *E. mimica* Brooker & Hopper subsp. *mimica*, *E. mimica* subsp. *continens* Brooker & Hopper, *E. incerata* Brooker & Hopper, *E. sporadica* Brooker & Hopper, *E. thamnoides* Brooker & Hopper subsp. *thamnoides*, *E. thamnoides* subsp. *megista* Brooker & Hopper, *E. utilis* Brooker & Hopper and *E. vesiculosa* Brooker & Hopper. The unpublished taxon *E. olivacea* ined., so-named in CANB, NSW and PERTH, is regarded as the same as *E. macrandra*. Similarly, *E. recondita* ined. is included in *E. vegrandis* L.A.S. Johnson & K.D. Hill.

A revised classification for species deriving from the publication of *Eucalyptus* subser. *Cornutae* is presented, following Brooker (2000), in which all the species with erect stamens fall into subsection *Hadrotes* Brooker and into several series of subsection *Glandulosae* Brooker. We discuss the diagnostic characters for each infra-generic taxon relevant to the taxa treated, and provide keys to the subsections, series and subseries, as well as keys to the species and subspecies. Representative specimens are illustrated in the plates and a distribution map for each new taxon is given.

The term 'marlock' is defined and applied to two of the species included in this study.

Introduction

The species treated in this paper either belong to the various infra-generic taxa deriving by natural affinity from *Eucalyptus* subser. *Cornutae* Benth. (Table 1) or have been incorrectly given taxonomic association with the subseries. All relevant species are endemic to the southern half of Western Australia and are now greatly increased in the number of published taxa since Bentham (1867). There are more than 30 species ranging geographically from *E. sargentii* Maiden subsp. *fallens* K.D. Hill & L.A.S. Johnson on Eurardy Station north of the Murchison River to *E. occidentalis* Endl. near Mt Ragged south of Balladonia, although both species are better known in their southern wheatbelt distributions. One species of the subseries occurs near the highest rainfall zone (*E. cornuta*) while *E. eremophila* (Diels) Maiden extends to the southern part of the Great Victoria Desert east of Kalgoorlie.

In bud morphology, the great majority of these species are probably the most easily recognised of all eucalypts by the long operculum accommodating completely erect stamens. No species of eastern or northern Australia could be confused in this character with the *Cornutae* (we use this name broadly in what may be regarded as the traditional sense to include *E.* ser. *Lehmannianae* D.J. Carr & S.G.M. Carr, *E.* ser. *Cornutae* (Benth.) Blakely and *E.* ser. *Erectae* Brooker), although Bentham alluded to similarities in *E. marginata* Sm. and *E. tereticornis* Sm. and related species. *E. fibrosa* F. Muell., another eastern species, could be included with these latter as it has many erect stamens but within much shorter opercula.

Two new taxa treated below, *E. cernua* Brooker & Hopper, and *E. vesiculosa* Brooker & Hopper, share the leaf surface, venation and oil gland pattern with *E.* subser. *Abundae* Brooker of *E.* ser. *Erectae*, *E. cernua* (incorrectly known as *E. nutans* F. Muell., see below) having invariably been included in this series. These two species plus *E. vegrandis* (see later) have much shorter opercula and differ fundamentally in stamen disposition.

At the beginning of this study we were uncertain as to the best way to treat related mallets and mallees, e.g. the established taxon, *E. astringens*, and the new taxa *redacta* (mallet), *thamnoides* (mallee), and *megista* (mallee) (see later). We have been to a certain extent guided by the recent DNA work of M. Byrne of the Western Australian Herbarium (pers. comm.). Her research showed that related tree taxa in the *E.* ser. *Loxophlebae* were genetically similar and distinct from the mallee taxa in the series. In other words, for the *Loxophlebae*, the specific boundary is clearly between habit form and not within habit. We cannot be certain that conclusions made from such a restricted study can be applied unequivocally to other series. However, we consider the two morphologically similar mallets in *E. astringens* and two morphologically similar mallees in the new species *E. thamnoides* fit the pattern in the *Loxophlebae*. By contrast, the more distinct but obviously related *E. lehmannii* (mallee) and *E. arborella* (mallet) are better recognised as species.

Conservation status is described only for those taxa currently declared as Rare Flora or given a priority code by the Department of Conservation and Land Management. Further survey is needed to document the distribution and status of most of these taxa (Kelly *et al.* 1995).

Use of the term marlock

The categorisation of habit in south-west Australian eucalypts has long been contentious. Brooker & Hopper (1991) discussed the history of the exclusively Western Australian terms 'marlock' or 'maalock' which have been used variously over the years. They pointed out that the term, which we prefer to standardise as 'marlock', has been used for quite different habit forms rendering it useless in

description and diagnosis. However, as the word continues to be used (e.g. Brooker & Kleinig 1990), but to this date without agreed definition, we consider it might as well be used for one of the characteristic habit forms. We apply it to the more or less pure stands of short, erect, thin-stemmed 'trees', that do not produce lignotubers. These are easily seen and recognised in stands of *E. platypus, E. vesiculosa,* and the unrelated *E. stoatei.* They can be distinguished from mallets which are taller and have a characteristic steep branching habit.

History of the *Cornutae*

Of the many characters Bentham (1867) used to delineate his subseries *Cornutae*, only one is usefully, though not exclusively (see above), diagnostic, viz., "Stamens erect or flexuose in the bud...". The species he included in the subseries (Table 1) all have erect stamens and the descriptive term "flexuose" is misleading.

Blakely (1934) recognised nineteen species in the group and raised the subseries to series. *Eucalyptus gomphocephala* DC., which was included elsewhere by Bentham, was placed in the new *E.* ser. *Cornutae* by Blakely (1934) and retained in this series by Pryor & Johnson (1971) and Chippendale (1988).

In the description of *E.* ser. *Cornutae,* Blakely, virtually paraphrasing Bentham, stated, "Stamens straight or flexuose in the bud." Of the listed species one, *E. nitens sens.* Blakely, has inflexed filaments which may be the reason he used the character "flexuose", not that this is a particularly apt term for the inflexion seen in this species. Within the series he recognised two subseries – *Sessiles* and *Pedicellatae.* We consider Blakely's diagnoses for the subseries to be uninformative and the lists of species that compose them to be heterogeneous.

Pryor & Johnson (1971) in their informal classification recognised, to a degree, the singularity of *Eucalyptus gomphocephala* when they isolated it in a monotypic subseries in *E.* ser. *Cornutae.* They categorised the remaining species into two groups (series) comprising three polytypic subseries. In doing so, they foreshadowed recognition of "*lehmannii*", "*platypus*" and "*occidentalis*" groups. Carr & Carr (1980) formally erected the *E.* series *Lehmannianae* to account for *E. lehmannii* and related species (Table 1). From the new series they excluded *E. cornuta* Labill. on account of the presence in this species of pith glands. The remaining taxa, viz. the "*platypus*" and "*occidentalis*" groups were not treated by Carr & Carr.

Table 1. The species constituting *Eucalyptus* subser. *Cornutae* Benth. (Bentham 1867) and *Eucalyptus* ser. *Lehmannianae* D.J. Carr & S.G.M. Carr (Carr & Carr 1980). The type species of each group is asterisked.

Subsection *Cornutae*	Series *Lehmannianae*
E. annulata Benth.	*E. bennettiae* D.J. Carr & S.G.M. Carr
**E. cornuta* Labill.	*E. burdettiana* Blakely & Steedman
E. lehmannii (Schauer) Benth.	*E. conferruminata* D.J. Carr & S.G.M. Carr
E. macrandra F. Muell. ex Benth.	**E. lehmannii* (Schauer) Benth.
E. occidentalis Endl.	*E. megacornuta* C.A. Gardner
E. platypus Hook.	*E. newbeyi* D.J. Carr & S.G.M. Carr
E. spathulata Hook.	*E. talyuberlup* D.J. Carr & S.G.M. Carr

In the recent comprehensive treatment of the genus, Chippendale (1988) presented "the current situation" in the classification. This assertion is ambiguous or misleading as 'series 45 *Cornutae*' in Chippendale includes, without qualification or segregation, the *Lehmannianae* D.J. Carr & S.G.M. Carr which was published some years before in 1980.

In treating only part of the *Cornutae* complex, Hill & Johnson (1992) recognised two series, both extra-codical, viz. *Astringentes* and *Erythronemae.* This latter series includes *Eucalyptus* ser. *Elongatae* Blakely, a neatly circumscribed group of four species distinct from the remainder of the complex in the strongly diagnostic character of inflexed stamens. Yet Hill & Johnson in the diagnosis for the *Erythronemae* give "filaments erect well before maturity of the buds". Hence the integration by them of the *E. spathulata* group of species (the first-named species in Hill & Johnson's *Erythronemae*) with the *E. erythronema* group (*Elongatae* in the strict sense) must be an error and we reject the association, unless they imply that the stamens at maturity become inflexed.

The revised classification for species deriving from the publication of *Eucalyptus* subser. *Cornutae* Benth.

In assessing the taxa so far referred to, we found existing classifications of the genus to be inadequate. Consequently, we formulated a revised system for the relevant part of the genus (Table 2) which was published by Brooker (2000). We reject any association of *Eucalyptus gomphocephala* with *Cornutae* species where it appeared in Maiden (1929) and Blakely (1934), or in *E.* subser. *Robustae* in which it was placed by Bentham (1867). It is appropriately placed in a monotypic section (Brooker 2000).

It has long been recognised that cotyledon shape is a strongly unifying character in *Eucalyptus*. Based on outgroup comparisons (e.g. Hall 1914), it is likely that the primitive cotyledon shape in the genus is reniform. Evolutionary modification has resulted in emargination of the distal edge. This is seen at its most extreme in the large group of species in which the cotyledonary blade is deeply notched forming a Y-shaped structure. This condition was recognised by Maiden (1933) when he erected a 'Division' *Bisectae* to accommodate the numerous species with this type of cotyledon. Pryor and Johnson adopted this scheme with their informal, extra-codical *E.* sect. *Bisectaria*. We now refer the species to the formal *E.* sect. *Bisectae* Maiden ex Brooker.

Of the species of *Eucalyptus* sect. *Bisectae* treated in this study, we recognise three principal groups: one with massive, rigid inflorescence structures (peduncles, buds and fruits), viz. *E.* subsect. *Hadrotes;* and the remainder with smaller buds and fruits, recently divided into two much larger groups, one with glands in the pith, *E.* subsect. *Glandulosae* (with the exception of some rare reversals in *E.* ser. *Levispermae*), and one lacking glands, *E.* subsect. *Destitutae* (Brooker 2000).

Adult leaf characters can be distinctive in *Eucalyptus* subsect. *Hadrotes* and parts of *E.* subsect. *Glandulosae*. The leaves are very smooth-surfaced, glossy and slightly olive-green. We have used the term 'glazed' for this character which is as readily assessed in the fresh specimen as in the dried. It occurs, for example, in *E.* ser. *Cornutae*, *E.* ser. *Lehmannianae* and *E.* subser. *Abundae* of *E.* ser. *Erectae*. *E.* subser. *Pedicellatae* of *E.* ser. *Erectae* does not have this character and can be easily distinguished with experience on both fresh and dried specimens, although *E. stowardii* of this subseries has glossy, but green not olive-green leaves. Glazed, olive-green leaves occur as well in *E.* ser. *Clinatae* which differs in the nature of the staminophore and androecium (see later).

A further character that distinguishes *Eucalyptus* subser. *Abundae* from *E.* subser. *Pedicellatae* is the staminophore which, in the former is broad, bearing the filaments in detectable whorls, and in the latter is narrow. The *E.* ser. *Clinatae* also has a narrow staminophore, distinguishing it from the *E.* ser. *Abundae*, in as much as the ring of tissue actually bearing the filaments is narrow, although there may be an extension of barren tissue inwards as in the completely unrelated *E.* sect. *Liberivalvae*.

The complete classification of *Eucalyptus* subsect. *Hadrotes* and *E.* subsect. *Glandulosae* is given in Table 2 where the monotypic *E.* sect. *Bolites*, comprising only *E. gomphocephala*, is also shown.

Table 2. Classification of part of *Eucalyptus* sect. *Bisectae* Maiden ex Brooker (Brooker 2000) and the re-assignment of *E. gomphocephala*. Series following *E. protensa* are listed for completion of *E.* subsect. *Glandulosae* although their constituent species are not given as they are not relevant to this paper.

Eucalyptus sect. *Bolites* Brooker
E. gomphocephala DC.
Eucalyptus sect. *Bisectae* Maiden ex Brooker
Eucalyptus subsect. *Hadrotes* Brooker
Eucalyptus ser. *Cornutae* (Benth.) Blakely
E. cornuta Labill.
E. macrandra F. Muell. ex Benth.
Eucalyptus ser. *Lehmannianae* D.J. Carr & S.G.M. Carr
Eucalyptus subser. *Conjunctae* Brooker
E. mcquoidii Brooker & Hopper,
E. lehmannii (Schauer) Benth.
E. arborella Brooker & Hopper
E. conferruminata D.J. Carr & S.G.M. Carr
Eucalyptus subser. *Liberae* Brooker
E. newbeyi D.J. Carr & S.G.M. Carr
E. talyuberlup D.J. Carr & S.G.M. Carr
E. burdettiana Blakely & Steedman
E. megacornuta C.A. Gardner
Eucalyptus subsect. *Glandulosae* Brooker
Eucalyptus ser. *Clinatae* Brooker
E. cernua Brooker & Hopper
E. vesiculosa Brooker & Hopper
E. vegrandis L.A.S. Johnson & K.D. Hill
Eucalyptus ser. *Erectae* Brooker
Eucalyptus subser. *Abundae* Brooker
Eucalyptus suprasp. *Angustae* Brooker
E. mimica Brooker & Hopper subsp. *mimica*
E. mimica subsp. *continens* Brooker & Hopper
E. steedmanii C.A. Gardner
E. spathulata Hook.
E. suggrandis L.A.S. Johnson & K.D. Hill subsp. *suggrandis*
E. suggrandis subsp. *alipes* L.A.S. Johnson & K.D. Hill
E. goniocarpa L.A.S. Johnson & K.D. Hill
Eucalyptus suprasp. *Longae* Brooker
E. incerata Brooker & Hopper.
E. tenera L.A.S. Johnson & K.D. Hill

E. depauperata L.A.S. Johnson & K.D. Hill
E. tephroclada L.A.S. Johnson & K.D. Hill
E. eremophila (Diels) Maiden
Eucalyptus suprasp. *Latae* Brooker
E. utilis Brooker & Hopper.
E. platypus Hook. subsp. *platypus*
E. platypus subsp. *congregata* Brooker & Hopper
Eucalyptus subser. *Pedicellatae* Blakely
E. sargentii Maiden subsp. *sargentii*
E. sargentii subsp. *fallens* K.D. Hill & L.A.S. Johnson
E. occidentalis Endl.
E. aspratilis L.A.S. Johnson & K.D. Hill
E. astringens (Maiden) Maiden subsp. *astringens*
E. astringens subsp. *redacta* Brooker & Hopper,
E. thamnoides Brooker & Hopper subsp. *thamnoides*
E. thamnoides subsp. *megista* Brooker & Hopper
E. stowardii Maiden
E. sporadica Brooker & Hopper
E. diminuta Brooker & Hopper
Eucalyptus subser. *Annulatae* L.A.S. Johnson & K.D. Hill ex Brooker
E. annulata Benth.
E. extensa L.A.S. Johnson & K.D. Hill
E. protensa L.A.S. Johnson & K.D. Hill
Eucalyptus ser. *Levispermae* Maiden
Eucalyptus ser. *Contortae* Blakely
Eucalyptus ser. *Stricklandiae* Brooker
Eucalyptus ser. *Accedentes* Chippend.
Eucalyptus ser. *Kruseanae* Chippend.
Eucalyptus ser. *Loxophlebae* Chippend.
Eucalyptus ser. *Obliquae* Blakely
Eucalyptus ser. *Dundasianae* Chippend.
Eucalyptus ser. *Elongatae* Blakely
Eucalyptus subsect. *Destitutae* Brooker

Descriptions

Eucalyptus sect. **Bolites** Brooker, *Aust. Syst. Bot.* 13: 94 (2000). *Type: Eucalyptus gomphocephala* DC.

Tree to 40 m tall with grey box-type rough bark to small limbs. *Branchlets* smooth, yellowish; pith glandular. *Cotyledons* more or less bilobed. *Juvenile leaves* petiolate, alternate, ovate or cordate, to 15 x 9.5 cm, thin, green. *Adult leaves* petiolate, alternate, lanceolate, to 16 x 2.5 cm, slightly discolorous, thin, green; reticulation dense and with very few, obscure oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncle erect, strongly flattened. *Buds* sessile to strongly and stoutly pedicellate, mushroom-shaped, to 2 x 1.2 cm; operculum hemispherical, rarely obtusely conical, wider than hypanthium. *Stamens* all fertile, outer ones oblique, inner flexed. *Ovules* in 4 vertical rows. *Fruit* sessile, more or less campanulate, to 2.2 x 1.7 cm, rim thick; disc level. *Seeds* black, flattish to saucer-shaped, often flanged, with distinct reticulum.

Notes. A section of one species occupying coastal dune and limestone habitats between Ludlow and Jurien, Western Australia. *E. gomphocephala* is widely planted as an ornamental in southern Australia. It is readily recognised by the robust tree habit, rough bark, yellowish branchlets, thin glossy adult leaves with dense reticulation, and mushroom-shaped buds.

Eucalyptus sect. **Bisectae** Maiden ex Brooker, *Aust. Syst. Bot.* 13: 98 (2000). *Type: Eucalyptus gracilis* F.Muell.

Cotyledons bisected.

Key to subsections of *Eucalyptus* sect. *Bisectae*

1. Buds to 7 cm long, much longer than wide; fruit large, thick-rimmed, held rigidly; stamens erect ..... subsect. **Hadrotes**
1. Buds smaller or slender, or if to 6 cm long, approximately as long as wide; fruit smaller and slender; stamens as given below
   2. Pith glandular; stamens erect or flexed ..... subsect. **Glandulosae**
   2. Pith not glandular; stamens never erect ..... subsect. **Destitutae**

Eucalyptus subsect. **Hadrotes** Brooker, *Aust. Syst. Bot.* 13: 98 (2000). *Type: Eucalyptus lehmannii* (Schauer) Benth.

Trees, *mallets* or *mallees* with rough or smooth bark. *Juvenile leaves* petiolate, elliptical to ovate or orbicular, to 10 x 7 cm. *Adult leaves* petiolate, lanceolate, narrowly lanceolate or elliptical, 4–14 x 1–3.5 cm, green to olive green, glazed, with intramarginal vein remote from leaf edge; reticulation often obscure with prominent irregular oil glands. *Inflorescences* axillary, unbranched, 7–50-flowered; pedunele flattened or terete. *Buds* sessile; operculum long, horn-shaped. *Disc* or *nectary* in form of convex mounds of tissue overlying valves; valves remaining united at their tip.

Key to the series of *Eucalyptus* subsect. *Hadrotes*

1. Seedling leaves smooth; pith of branchlets usually glandular ..... ser. **Cornutae**
1. Seedling leaves scabrid; pith of branchlets without glands ..... ser. **Lehmannianae**

Eucalyptus ser. **Cornutae** (Benth.) Blakely, *Key Eucalypts* 22, 106 (1934). *Type: Eucalyptus cornuta* Labill.

Mallee to tall *tree*, with decussate phyllotaxis. *Seedlings* (?not) scabrous. *Pith of branchlets* usually with glands. *Peduncles* terete or only slightly flattened.

Notes. A series of two species. Brooker & Kleinig (1990: 159) treated a proposed additional species as *Eucalyptus olivacea* Brooker & Hopper ined. Preliminary observations suggested that this taxon was a smooth-barked mallee with larger buds and fruit than *Eucalyptus macrandra*, and with a more northerly distribution. However, the distinctions do not hold, particularly the bud and fruit details, and both rough- and smooth-barked variants occur in the same locality, for instance, in the Stirling Range. Further field study may reveal bark differences to be associated with the age of the plant. On current evidence, we consider *E. olivacea* ined. to be conspecific with *E. macrandra*.

Eucalyptus cornuta has a fairly wide distribution in southern coastal Western Australia including islands off the south coast. It has been greatly depleted in numbers through the felling of the larger trees for construction purposes because of its excellent timber. In the poorer (particularly eastern) parts of its distribution it is reduced to a mallee. The species has been in cultivation in other parts of southern Australia for many years.

Carr & Carr (1980) referred to the pith glands of *E. cornuta* vis-à-vis *E.* ser. *Lehmannianae.* They stated that from an examination of specimens over 'most of its range', ...'the species always has glandular pith.' From an examination in CANB of about twenty specimens of *E. cornuta* over its range from west to east, we find that most specimens have pith glands. In a few others the glands were not evident and it may be that, if the character is diagnostic for the species as Carr & Carr imply, the glands in some specimens are minute, obscure or present at some nodes and not others.

The taxon described below the key is believed to be a hybrid of *Eucalyptus cornuta* and an entirely unrelated species, *E. angulosa* Schauer, of *E.* sect. *Dumaria.* We assign no further infra-generic status for it.

Key to species of *Eucalyptus* ser. *Cornutae*

1. Disc of fruit domed, extending over prominently exserted valves which remain coherent at the tips ..... **E. cornuta**
1. Disc of fruit flat; valves reaching to rim, not coherent ..... **E. macrandra**

1. Eucalyptus x missilis Brooker & Hopper, *nothosp. nov.*

Frutex "mallee" ad 3 m altus cortice laevi. Cotyledones bilobae. Folia adulta nitentia, viridia, ad 8 x 3 cm. Inflorescentiae 7 vel multiflorae; pedunculi erecti. Alabastra sessilia vel breviter pedicellata, lato-fusiformia, ad 1.8 x 0.7 cm operculo conico. Aliquot stamina exteriora erecta, cetera inflexa. Fructus sessiles, cupulati, ad 1.5 x 1.5 cm, laeves vel costati. Valvae 3 vel 4, exiles et aliquamdiu apicem versus connexae.

Typus: Cheyne Beach, 34°53'S, 118°23'E, Western Australia, 3 June 1983, *M.I.H. Brooker* 8155 & *S.D. Hopper* (*holo:* PERTH; *iso:* AD, CANB, MEL, NSW).

Mallee to 3 m tall, with smooth bark. *Pith of branchlets* glandular. *Cotyledons* bilobed. *Seedling leaves* remaining opposite for 2 or 3 pairs, petiolate. *Adult leaves* alternate, petiolate, broadly lanceolate to elliptical, to 8 x 3 cm, glossy, green. *Inflorescences* axillary, unbranched, 7–many-flowered; peduncles erect, stout, flattened, to 2.5 cm long. *Buds* sessile or shortly pedicellate, broadly fusiform, to 1.8 x 0.7 cm; operculum conical. *Stamens:* some outer ones erect, others inflexed. *Anthers* versatile, dorsifixed, oblong, opening by longitudinal slits. *Ovary* 3- or 4-locular; ovules in 4 vertical rows on placenta. *Fruit* sessile, cupular, to 1.5 x 1.5 cm, smooth or ribbed; valves 3 or 4, not exceeding the thick rim, slender at the tips which are united for a time. *Seeds* black, flattened, shallowly ribbed on vertical side, smooth on dorsal side. (Figure 1)

Other specimens examined. WESTERN AUSTRALIA: Thistle Cove, 18 Mar. 1972 *K.M. Allan* 847 (CANB, PERTH); Gully north of Mt Le Grand, 15 Sep. 1978, *D.F. Blaxell* (BRI, CANB, K, MEL, NSW); Cheyne Beach, 3 June 1983, *D.F. Blaxell* (CANB, NSW, PERTH); Esperance, 21 Jan. 1970,

Figure 1. Buds and fruits of *Eucalyptus* x *missilis* (*Brooker* 7171).

M.I.H. Brooker 2519 (CANB, NSW, PERTH); Coronet Creek, 4 Apr. 1977, *M.I.H. Brooker* 5645 (CANB, NSW, PERTH); W end of Thistle Cove, 4 Apr. 1977, *M.I.H. Brooker* 5651, 5653 (AD, CANB, MEL, NSW, PERTH); Cheyne Beach, Dec. 1979, *M.I.H. Brooker* 6686 (CANB, NSW, PERTH); Cheyne Beach to Mermaid Point, Nov. 1981, *M.I.H. Brooker* 7171, 7171a (CANB, NSW, PERTH); Hood Point, 9 Mar. 1988, *M.I.H. Brooker* 9919 (CANB, PERTH); Flinders Peninsula, 20 July 1988, *M.I.H. Brooker* 9994 (AD, CANB, MEL, NSW, PERTH); Sinker Reef area, Two Peoples Bay, E of Albany, 24 Jan. 1973, *N.T. Burbidge* 8105 (CANB, PERTH); Cheyne (Hassell) Beach, 1.3 km SW of caravan park along Mermaid Point track, 34°54'S, 118°23'E, 21 Nov. 1979, *S.D. Hopper* 1567 (PERTH); 3 km SE of Mt Le Grand, 2.4 km S of Lucky Bay Road on Hellfire Bay Road, 3 May 1982, *S.D. Hopper* 2275 (PERTH); West Cape Howe, 29 Oct. 1988, *L.A.S. Johnson* 9150 & *B. Briggs* (CANB, NSDW, PERTH); between Limestone Head and Bald Head, Flinders Peninsula, Torndirrup, S of Albany, 6 July 1986, *G.J. Keighery* 8164, 8165, (PERTH); 2.1 km NW of Mt Gardner, Two Peoples Bay Nature Reserve, 21 Apr. 1988, *N.K. McQuoid s.n.* (PERTH); West Cape Howe National Park, 27 Jan. 1996, *D. Nicolle* 1671 (CANB, PERTH).

Distribution and habitat. Western Australia: coastal, of scattered occurrence from West Cape Howe National Park east to Cape Le Grand, on sand over limestone or granite. (Figure 2A)

Flowering time. January to April.

Conservation status. Conservation Codes for Western Australian Flora: Priority Four. *Eucalyptus* x *missilis* is numerically rare but widely distributed and found on several conservation reserves including William Bay National Park, Two Peoples Bay Nature Reserve and Cape Le Grand National Park.

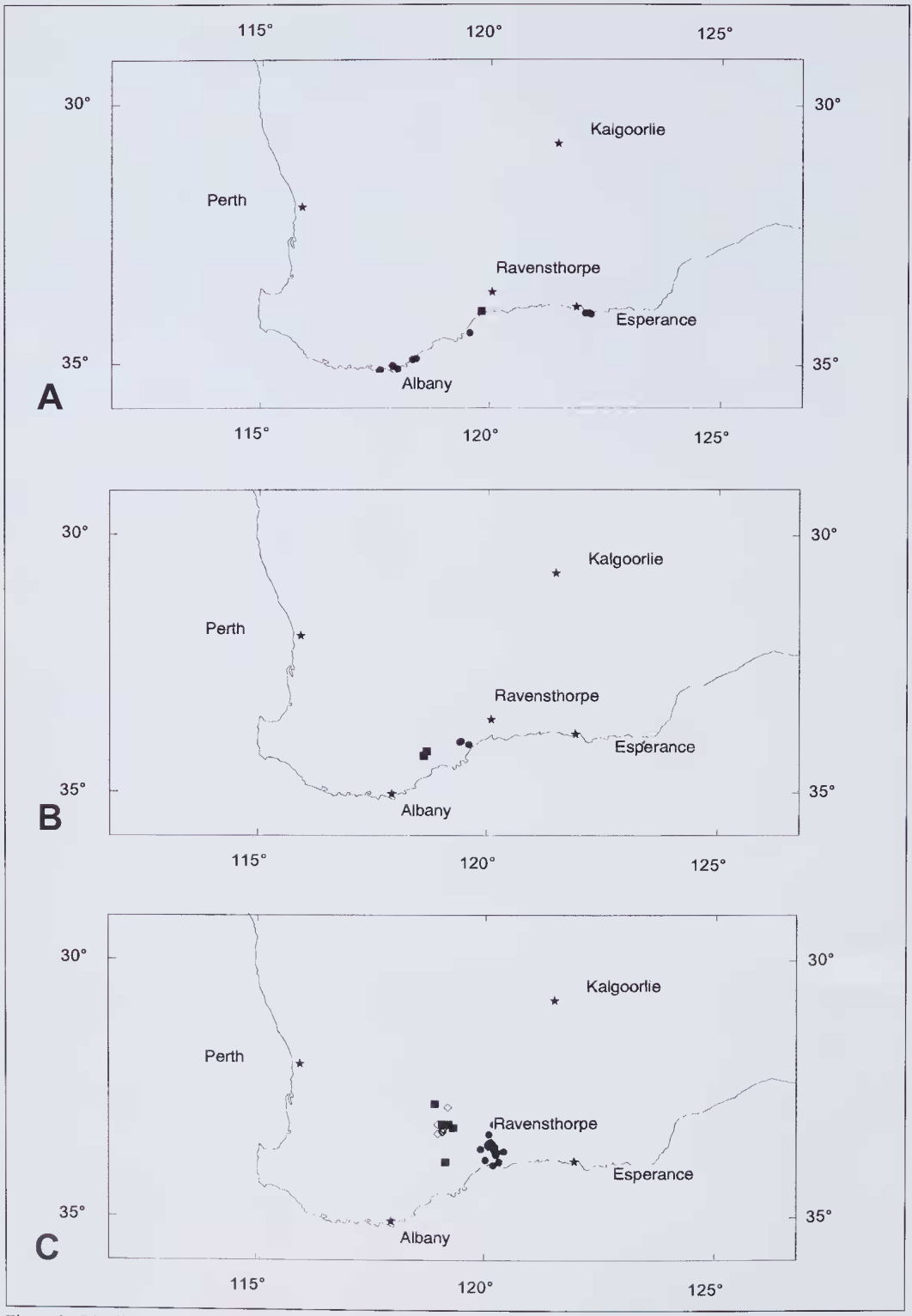

Figure 2. Distribution maps. A – *Eucalyptus mcquoidii* ■ and *E.* x *missilis* ●; B – *E. arborella* ● and *E. vesiculosa* ■; C – *E. cernua* ●, *E. mimica* subsp. *continens* ◇and *E. mimica* subsp. *mimica* ■.

Etymology. This species has been known to us for many years as "bullet bush" because of the bud shape and is given a name reflecting this, from the Latin *missilis* – that which may be thrown.

Notes. Flowers of this taxon have only been observed in bud. *Eucalyptus* x *missilis* has a very scattered distribution not unlike the hybrid species *E. erythrandra* Blakely & Steedman which was demonstrated to be a hybrid of *E. angulosa* and *E. tetraptera* Turcz. (Beard 1976). It does not occur in large populations and is usually found growing with both *E. angulosa* and *E. cornuta* in the vicinity. Recently the authors collected it at Cape Hood where *E. angulosa* occurred in abundance but no *E. cornuta* was seen in a brief search although this is a typical coastal site within the known distribution of the species.

Eucalyptus x missilis has characteristics consistently intermediate between *E. cornuta* and *E. angulosa*, the most contrasting diagnostic features of these species being the wholly erect stamens of the former and the inflexed stamens of the latter. In *E. x missilis*, some outer stamens are erect and the rest are inflexed. The new species is also intermediate in leaf, valve, seed and seedling characters.

In a glasshouse trial to test for comparative morphology, *Eucalyptus x missilis* progeny segregated for some seedling characters. This provides further evidence of a likely hybrid origin for the species. However, we consider that the morphological uniformity of mature individuals within and between all populations justifies taxonomic recognition of the species.

Eucalyptus ser. **Lehmannianae** D.J. Carr & S.G.M. Carr, *Austral. J. Bot.* 28: 523 (1980). *Type: Eucalyptus lehmannii* (Schauer) Benth.

Tree, shrub, mallee or *mallet*, with whorled phyllotaxis. *Seedlings* scabrous. *Pith of branchlets* without glands. *Peduncles* flattened or terete. *Staminal filaments* lemon-green.

Key to subseries of *Eucalyptus* ser. *Lehmannianae*

1. Hypanthia of most or all buds and fruits within an inflorescence fused ..... subser. **Conjunctae**
1. Hypanthia of all buds free ..... subser. **Liberae**

Eucalyptus subser. **Conjunctae** Brooker, *Aust. Syst. Bot.* 13: 99 (2000). *Type: Eucalyptus lehmannii* (Schauer) Benth.

Mallets, small *trees* or *mallees*. *Adult leaves* green, slightly glossy; intramarginal vein well removed from leaf edge in broader-leaved species. *Inflorescences* axillary, unbranched; peduncle long, stout, subtending more than 7 flowers fused by their hypanthia and remaining fused in fruit. *Buds* with operculum many times longer than wide. *Stamens* erect. *Filaments* pale lemon-green, massed in a ball when in full flower. *Fruit valves* exserted, remaining fused at their tips.

Notes. This subseries consists of four species, all of which have been referred to *Eucalyptus lehmannii* previously because of their fused hypanthia. Fused hypanthia are a unique feature of this subseries, distinguishing it from the remainder of thegenus. Other obvious characters of the subseries are the remote intramarginal vein of the adult leaves, the very numerous buds, long opercula and lemon-green stamens. The species occur in coastal and subcoastal areas from the Stirling Range eastwards to the Wittenoom Hills and also on many offshore inlands.

Key to species in *Eucalyptus* subser. *Conjunctae*

1. Peduncle terete ..... 2. **E. mcquoidii**
1. Peduncle flattened
2. Operculum < 5 times as long as wide, thick ..... **E. conferruminata**
2. Operculum > 5 times as long as wide, slender
3. Mallee ..... **E. lehmannii**
3. Small tree ..... 3. **E. arborella**

2. Eucalyptus mcquoidii Brooker & Hopper, *sp. nov.*

Eucalypto lehmannii (Schauer) Benth. affinis, a qua habitu arborescenti, foliis parvis angustioribusque (ad 1.5 cm latis), insignite pedunculis teretis et usque ad 50 alabastra in quoque inflorescentia differt.

Typus: west of estuary 200 m NW of Quoin Head campsite, Fitzgerald River National Park, Western Australia, 6 April 1995, *M.I.H. Brooker* 12198W (*holo:* CANB; *iso:* AD, NSW, PERTH).

With affinity to *Eucalyptus lehmannii* (Schauer) Benth. from which it differs in the tree habit (branching low on the trunk), small narrower juvenile leaves, to 6 x 1.5 cm, notably terete peduncles and up to 50 buds per inflorescence (to 21 in *E. lehmannii*). (Figure 3)

Other specimens examined. WESTERN AUSTRALIA: 7.7 km S of Telegraph Track on way to Quoin Head, Fitzgerald River National Park, 6 Apr. 1995, *M.I.H. Brooker* 12197W (CANB); 1 km W of Quoin Head, Fitzgerald River National Park, 6 Oct. *C.J. Robinson* 1183 (PERTH); 0.75 km NNW of Quoin Head, 25 Dec. 1988, *E.M. Sandiford* (PERTH).

Distribution and habitat. Known only from near Quoin Head, Fitzgerald River National Park, Western Australia, on cliff-top on a branch of creek. On a steep slope of skeletal soils deriving from shale and quartzite. (Figure 2A)

Flowering period. Unknown.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. *Eucalyptus mcquoidii* is numerically rare and highly localised. The future of this fire-sensitive obligate-seeder species in Fitzgerald River National Park is secure provided fire frequencies are managed to ensure adequate canopy-stored seed is present.

Etymology. Named after Nathan McQuoid, botanist and collector, formerly Head Ranger of Fitzgerald River National Park, who has assisted us in many ways with the taxonomy of the Western Australian eucalypts, and who is the discoverer of *Eucalyptus vesiculosa*, newly published below in this paper.

Notes. Although no flowering material has been collected in the field, the species is known to produce the lemon-green stamens typical of this subseries in cultivation. It is quite distinctive in its terete peduncles.

3. Eucalyptus arborella Brooker & Hopper, *sp. nov.*

A *Eucalypto lehmannii* habitu arborescenti, foliis plantularum deltoideis ad 4 cm latis et praesentibus in clivis petrosis differt.

Figure 3. Holotype of *Eucalyptus mcquoidii*.

Typus: Fitzgerald River National Park, 1.5 km south-east of Twertup Field Studies Centre, Western Australia, 12 March 1989, *S.D. Hopper* 7131 (*holo:* PERTH; *iso:* AD, CANB, MEL, NSW).

Differs from *E. lehmannii* by the tree habit (branching low on the trunk), juvenile leaves deltoid, broader, to 4 cm wide (in *E. lehmannii* ovate, to 3.5 cm wide), and the occurrence on stony sites (*E. lehmannii* occurs mostly on sandy plains). (Figure 4A)

Other specimens examined. WESTERN AUSTRALIA: Fitzgerald Inlet, Fitzgerald Reserve, 34°05'S, 119°34'E, 3 Aug. 1970, *M.I.H. Brooker* 2701 (PERTH, CANB); Harric Hill, 1.5 km SE of Twertup Cottage, Fitzgerald National Park, 26 Nov. 1991, *M.I.H. Brooker* 10918 (AD, CANB, MEL, NSW, PERTH); Twertup Hill, E of cottage, Fitzgerald River National Park, 18 Aug. 1999, *M.I.H. Brooker* 13035 (CANB, PERTH); Fitzgerald River National Park, 6.2 km W of bed of Fitzgerald River on Fitzgerald Inlet Road, 12 Mar. 1989, *S.D. Hopper* 7132 (AD, CANB, MEL, NSW, PERTH); Fitzgerald River National Park, 5.5 km NNW of mouth of Fitzgerald River, on NE slopes above inlet, 12 Mar. 1989, *S.D. Hopper* 7133 (AD, CANB, MEL, NSW, PERTH); Fitzgerald River National Park, 500 m S of telegraph track on Quoin Head track, 13 Mar. 1989, *S.D. Hopper* 7134, 7135 (AD, CANB, MEL, NSW, PERTH); hill *c.* 1.5 km SE of Twertup Field Studies Centre, Fitzgerald River National Park, 7 Apr. 1995, *S.D. Hopper* 8325 (PERTH).

Distribution and habitat. Known only from the Fitzgerald River National Park, Western Australia, where it forms low woodlands on breakaways, rocky slopes and rocky creek lines with *E. astringens*, *E. clivicola* Brooker & Hopper, *E. falcata* Turcz., *E. uncinata* Turcz., *Banksia laevigata* and *B. media*. (Figure 2B)

Flowering time. March to May.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. *Eucalyptus arborella* is somewhat rare but secure in Fitzgerald River National Park provided fire frequencies are managed to ensure adequate canopy-stored seed is present in this fire-sensitive obligate-seeder species.

Etymology. From the Latin, *arbor* (tree), with the diminutive suffix, *ella*.

Notes. The species is closely related to *E. lehmannii*, differing principally in its tree habit.

Eucalyptus subser. **Liberae** Brooker, *Aust. Syst. Bot.* 13: 99 (2000). *Type: Eucalyptus burdettiana* Blakely & Steedman

Mallets or *mallees*. *Adult leaves* alternate, petiolate, narrowly lanceolate to lanceolate, to 9 x 1.7 cm green to blue-green, slightly glossy; intramarginal vein well removed from leaf edge. *Inflorescences* axillary, unbranched; peduncle long, flattened, subtending 3–13 free flowers. *Buds* sessile, elongated, to 5 x 1 cm; operculum many times longer than wide, smooth or warty. *Stamens* erect. *Filaments* pale lemon-green. *Fruit* sessile, campanulate, to 2 x 2.5 cm; valves exserted, remaining fused at their tips for a while.

Notes. This subseries comprises the remainder of *E.* series *Lehmannianae*, i.e. those species with free buds and fruits. Four species are recognised. For descriptions of these species see Carr & Carr (1980) and Brooker & Kleinig (1990).

Figure 4. Buds and fruits. A – *E. arborella* (*Brooker* 10918); B – *E. cernua* (*Brooker* 12922); C – *E. vesiculosa* (*Brooker* 12213W).

Key to species of *Eucalyptus* subser. *Liberae*

1. Operculum smooth
 2. Fruit to 1.7 cm wide; buds 7–13; mallee or small tree ..... **E. talyuberlup**
 2. Fruit 2–3 cm wide; buds 3–7; mallet ..... **E. newbeyi**
1. Operculum warty
 3. Operculum warts few, small; mallee ..... **E. burdettiana**
 3. Operculum warts many, prominent; mallet ..... **E. megacornuta**

Eucalptus subsect. **Glandulosae** Brooker, *Aust. Syst. Bot.* 13: 99 (2000). *Type: Eucalyptus annulata* Benth.

Pith of branchlets glandular.

Note. With the subtraction of the *Eucalyptus* subsection *Hadrotes* above, the section *Bisectae* comprises a large number of series which divide into two large groups, one of which with pith glands we address in some detail below.

Key to series of *Eucalyptus* subsect. *Glandulosae*

1. Seed spherical to cuboid ..... ser. **Levispermae**
1. Seed compressed-ovoid to flattish
 2. All stamens erect in unopened bud ..... ser. **Erectae**
 2. Some or all stamens inflexed in unopened bud
  3. Seedcoat honey-combed on dorsal side ..... ser. **Contortae**
  3. Seedcoat not honey-combed
   4. Seed with terminal hilum ..... ser. **Stricklandiae**
   4. Seed with ventral hilum
    5. Crown comprising juvenile leaves ..... ser. **Kruseanae**
    5. Crown comprising adult leaves
     6. Adult leaves > 2.5 cm wide, very thick, not flexible ..... ser. **Obliquae**
     6. Leaves < 2.5 cm wide, flexible
      7. Style narrowed at base or articulate ..... ser. **Loxophlebae**
      7. Style widening at base
       8. Leaf oil glands minute or obscure; juvenile leaves glossy ..... ser. **Dundasianae**
       8. Leaf oil glands distinct; juvenile leaves dull
        9. Peduncles terete ..... ser. **Elongatae**
        9. Peduncles flattened
         10. Leaf reticulation distinct ..... ser. **Accedentes**
         10. Leaf reticulation obscured by very numerous oil glands ..... ser. **Clinatae**

Eucalyptus ser. **Clinatae** Brooker, *Aust. Syst. Bot.* 13: 99 (2000). *Type: Eucalyptus cernua* Brooker & Hopper

Some or all stamens inflexed in bud; leaf oil glands distinct and very numerous, obscuring the leaf reticulation.

Notes. A series of three species, which share the glazed leaf surfaces and great leaf oil gland density and lack of reticulation of *Eucalyptus* ser. *Erectae* subser. *Abundae*.

Key to species of *Eucalyptus* ser. *Clinatae*

1. Infloreseenees ereet; opereulum smooth; flowers ereamy white ..... **E. vegrandis**
1. Infloreseences down-turned; flowers red
2. Opereulum warty; adult leaves to 7 x 4 em; marloek ..... 4. **E. vesiculosa**
2. Opereulum smooth; adult leaves to 10 x 2.5 em; mallee or mallet ..... 5. **E. cernua**

Notes. Aeeording to the protologue of Hill & Johnson (1992), the stamens of *Eucalyptus vegrandis* are ereet. Disseetion of the isotype in CANB and of some other specimens eited by the authors shows that the stamens, arising from a narrow staminophore, are mostly if not all inflexed. Henee, our inelusion of the speeies in the *E.* ser. *Clinatae*.

Hill & Johnson inelude both *Eucalyptus vegrandis* and *E. spathulata* in their extra-codieal series *Erythronemae* subseries *Platypodosae*. Among the eharaeters they use to diagnose this subseries is that the filaments are ereet "well before maturity", and it must be assumed from this that stamen disposition is maintained to bud maturity. Disseetion of *E. spathulata* buds eonfirms, by eontrast with *E. vegrandis*, that the stamens are all ereet, arising from a broad staminophore in several whorls, thus plaeing it in *E.* ser. *Erectae* subser. *Abundae*.

From the study of numerous field eolleetions, we had intended to reeognise another taxon, *Eucalyptus recondita* Brooker & Hopper ined., also with inflexed stamens (see Brooker & Kleinig 1990). From the large number of speeimens of this taxon and typieal *E. vegrandis* in CANB, we reeognise a more or less eontinuous gradient between the two. It beeame elear the two taxa were best treated as one. Typical *E. vegrandis* is at the narrow-leaved end of the gradient and *E. recondita* ined. at the broad-leaved end. The latter name should now be disregarded in favour of the former, unless other faetors subsequently found lead to its reeognition, possibly at the subspeeies level.

4. Eucalyptus vesiculosa Brooker & Hopper, *sp. nov.*

A *Eucalypto cernuae* foliis adultis late elliptieis in petiolis longioribus, alabastris valde angulatis, opereulis vesieulosis, floribus eonstanter rubris, et praesentia in societatibus plus minusve puris differt.

Typus: Boxwood Hill–Ongerup road, 4 km west of Norman Rd, east of Monjemup Rd, Western Australia, 8 April 1995, *M.I.H. Brooker* 12213 W & *S.D. Hopper* (*holo:* CANB; *iso:* AD, NSW, PERTH).

Differs from *Eucalyptus cernua* by the broadly elliptieal adult leaves on longer petioles, strongly angled buds, prominently warty opereula, eonsistently red flowers, and oeeurrence in more or less pure stands. (Figure 4C)

Other specimens examined. WESTERN AUSTRALIA: Corackerup Nature Reserve, 19 Sep. 1999, *M.I.H. Brooker* 13043 (CANB, PERTH); about 40 km SW of Jerramungup on the Boxwood Hill–Ongerup road between Monjemup Rd and Norman Rd (1.3 km from Monjemup Rd), Oct. 1994, *N. McQuoid* 1, 2 (CANB, PERTH); Boxwood Hill–Ongerup road, between Norman Rd and Monjemup Rd at edge of Corackerup Nature Reserve, 5 May 1999, *A. Slee* 4133 (CANB, PERTH), 4134 (CANB).

Distribution and habitat. Ongerup area of Western Australia. Known only from two loealities where it oeeurs in a more or less pure stand with some *E. annulata* and *E. neutra* on a reddish elay flat, on ground gently sloping northwards towards lateritie breakaways of the reserve. (Figure 2B)

Flowering time. September to October.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. *Eucalyptus vesiculosa* is highly localised, locally abundant, and occurs in Corackerup Nature Reserve.

Etymology. From the Latin, *vesiculosus* (covered with blisters), in reference to the warty operculum.

Notes. Eucalyptus vesiculosa occurs in an extensive, more or less pure, erect marlock stand of similar height to *E. platypus.* It could be mistaken for this species from a distance, but differs clearly by the angled buds and prominently warty opercula. It has broader leaves, longer petioles, and more strongly angled buds and fruits than its close relative *E. cernua,* which does not occur in 'pure' stands.

5. Eucalyptus cernua Brooker & Hopper, *sp. nov.*

[*Eucalyptus nutans auct. mult. non* F. Muell. (see below).]

Frutex "mallee" vel "mallet" ad 4 m altus arbore summa dense rotundata. Folia adulta breviter petiolata, elliptica, ad 10 x 2.5 cm, nitentia, olivacea vel atroviridia, dense glandulifera. Inflorescentiae axillares, 7-florae, pedunculi deflexi. Alabastra ovoidea, ad 1.8 x 0.7 cm, operculo brevi rotundato. Aliqua vel omnia stamina inflexa. Flores rubra. Fructus cupulati vel obconici, ad 1.3 x 1.3 cm.

Typus: 4.6 km N of Ravensthorpe–Albany road on Lake Grace road, 34°33'S, 120°00'E, Western Australia, 4 September 1987, *M.I.H. Brooker* 8657 (*holo:* CANB; *iso:* AD, MEL, NSW, PERTH).

Mallee or *mallet* to 4 m tall, with smooth bark. *Pith of branchlets* glandular. *Cotyledons* bisected. *Seedling leaves* alternate, petiolate, ovate to deltoid, to 7 x 5 cm, green. *Adult leaves* alternate, shortly petiolate, elliptical to lanceolate, to 10 x 2.5 cm, concolorous, olive green to dark green, glossy; intramarginal vein well removed from leaf edge; side veins usually distinct but further reticulation not visible, with very numerous oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncle strongly flattened, rigidly down-turned, to 2.6 cm long. *Buds* sessile or on a short, stout, tapering pedicel, more or less ovoid or rhomboidal in outline, to 1.8 x 0.7 cm, with operculum narrower than the strongly ribbed hypanthium. *Stamens* either some outer ones erect with others inflexed, or all inflexed. *Anthers* versatile, oblong, opening by longitudinal slits. *Flowers* red or rarely creamy white. *Ovary* 3–5-locular; ovules in 4 vertical rows on placenta. *Fruit* sessile, cupular to obconical, ribbed, to 1.3 x 1.3 cm; rim thick; disc annular to descending; valves 3–5, scarcely exserted. *Seeds* grey-brown, shallowly reticulate on dorsal side. (Figure 4B)

Other specimens examined. WESTERN AUSTRALIA: N side of Mt MacMahon, NE of Ravensthorpe, 14 Sep. 1978, *D. Blaxell* 1737 (CANB, NSW, PERTH); 4.7 km NW of highway 1 on Ravensthorpe–Lake King road, 10 Oct. 1984, *B.Briggs* 7717 & *L. Johnson* (AD, CANB, MEL, NSW, PERTH); *c.* 3 miles [5 km] NE of Kundip, 7 Apr. 1974, *M.I.H. Brooker* 4462 (CANB, PERTH); 8.5 km N of Jerdacuttup road, t/o on Ravensthorpe–Hopetoun road, 26 Nov. 1985, *M.I.H. Brooker* 9115, (CANB); E of Mt MacMahon on fire trail along N side of range near bottom of slope, 7 Apr. 1995, *M.I.H. Brooker* 12205 W (AD, CANB, NSW, PERTH); 9 km from Ravensthorpe–Jerramungup road on Cocibarup Rd from east, 7 Apr. 1995, *M.I.H. Brooker* 12207 W (AD, CANB, NSW, PERTH); 100 m from highway 1 along Eldverdton Rd, E of Ravensthorpe, 31 Aug. 1998, *M.I.H. Brooker* 12922 (CANB, PERTH); 6.7 km SE of Ravensthorpe, 26 Mar. 1968, *G.M. Chippendale* 415 (CANB, MEL, NSW, PERTH); 17.5 km SE of Ravensthorpe, 9 Jan. 1979, *M.D. Crisp.* 4979 (CANB, NSW PERTH); 4 km W of Annie Peak,

Fitzgerald River National Park, 11 Jan. 1979, *M.D. Crisp* 5030 (CANB, PERTH); Ravensthorpe district, Nov. 1944, *C.A. Gardner s.n.* (CANB, PERTH); Kundip, 23 Oct. 1961, *C.A. Gardner* 13722 (CANB, PERTH); 20 km by road SSE of Ravensthorpe on Hopetoun road, 17 Sep. 1976, *L. Haegi* 1010 (AD, CANB); 8.4 km S of highway on Mason Bay Rd, 9 Nov. 1986, *K.D. Hill* 2364 (PERTH); 1 km SW of Bandalup Hill, 20 Jan. 1981, *G.J. Keighery* 3712 (PERTH); Hopetoun, Nov. 1909, *J.H. Maiden* (NSW H5615) (CANB, NSW); Ravensthorpe–Hopetoun road, 15 Jan. 1970, *S.L. Paul* 83, 85 (CANB, PERTH); 19 km N of Hopetoun, 13 Aug. 1951, *R.D. Royce* 3674 (PERTH); 5 km E of Ravensthorpe, 5 Oct. 1966, *P.G. Wilson* 5534 (CANB, PERTH); 1 km S of Ravensthorpe, 21 May 1967, *P.G. Wilson* 5877 (CANB, PERTH); 18 miles from Hopetoun towards Ravensthorpe, 27 Oct. 1968, *J. Wrigley* (CANB 036802).

Distribution. In and around the Ravensthorpe Range, Western Australia. (Figure 2C)

Flowering time. September to January.

Etymology. From the Latin, *cernuus* (nodding, towards the earth), referring to the down-turned inflorescences.

Notes. Eucalyptus cernua is the red-flowering (rarely creamy white) mallee known commonly until recently as *E. nutans*, the type of which is *E. platypus* and is from Bremer Bay, well to the south-west of the known occurrences of *E. cernua*. The relationship of *E. cernua* to *E. vesiculosa* is given above.

Eucalyptus ser. **Erectae** Brooker, *Aust. Syst. Bot.* 13: 100 (2000). *Type: Eucalyptus annulata* Benth.

Stamens erect in bud.

Notes. A series comprising three subseries, *Eucalyptus* subser. *Annulatae*, the three species of which were treated by Johnson & Hill (1991), and two other much larger subseries which include several of the new species treated in this paper.

Key to subseries in *Eucalyptus* ser. *Erectae*

1. Seedcoat deeply pitted ..... subser. **Annulatae**
1. Seedcoat shallowly reticulate
   2. Secondary veins of adult leaf obscure and further reticulation not seen; staminophore broad ..... subser. **Abundae**
   2. Secondary veins of adult leaf distinct; tertiary veining present; staminophore narrow ..... subser. **Pedicellatae**

Eucalyptus subser. **Abundae** Brooker, *Aust. Syst. Bot.* 13: 100 (2000). *Type: Eucalyptus platypus* Hook.

Mallees or *mallets*, with smooth bark. *Pith of branchlets* glandular. *Adult leaves* glossy, olive green, with obscure side veins and very numerous oil glands. *Stamens* erect, arising in several whorls from a broad, flat staminophore.

Notes. A subseries of 12 species, three of which each comprise two subspecies. It corresponds with part of *Eucalyptus* ser. *Elongatae* Blakely *sensu* Chippendale 218 (1988) and is equivalent to the informal *Eucalyptus* subser. *Platypodinae* Pryor & Johnson, "Class. Eucs" 44 (1971).

Key to *Eucalyptus* subser. *Abundae*

1. Buds in groups of 3
 2. Outer operculum held to bud maturity ..... 6b. **E. mimica** subsp. **continens**
 2. Outer operculum shed before bud maturity or split into sepals
  3. Outer operculum shed whole before bud maturity
   4. Fruit prominently 2-winged longitudinally ..... **E. goniocarpa**
   4. Fruit not winged
    5. Pedicels winged, > 4 mm long ..... **E. suggrandis** subsp. **alipes**
    5. Pedicels not winged, < 4 mm long ..... **E. suggrandis** subsp. **suggrandis**
  3. Outer operculum split into sepals
   6. Buds to 2.3 x 0.5 cm ..... 6a. **E. mimica** subsp. **mimica**
   6. Buds to 3.3 x 1.3 cm ..... **E. steedmanii**
1. Peduncles with 7 or more flowers
 7. Buds and fruit glaucous
  8. Whole aspect of plant strongly glaucous; peduncles 7-flowered; fruit to 1.4 x 1.3 cm ..... 7. **E. incerata**
  8. Branchlets, buds and fruit lightly glaucous; peduncles with more than 7 flowers; fruit to 1.1 x 1 cm ..... **E. tephroclada**
 7. Buds and fruit not glaucous
  9. Adult leaves > 2 cm wide
   10. Peduncles erect, up to 2.5 cm long ..... 8. **E. utilis**
   10. Peduncles down-curved, up to 4 cm long
    11. Adult leaves orbicular, to 3.5 cm wide ..... **E. platypus** subsp. **platypus**
    11. Adult leaves elliptical, to 2.5 cm wide ..... 9. **E. platypus** subsp. **congregata**
  9. Adult leaves < 2 cm wide
   12. Adult leaves to 0.4 cm wide ..... **E. spathulata**
   12. Adult leaves to > 0.4 cm wide
    13. Operculum warty ..... **E. suggrandis** subsp. **suggrandis**
    13. Operculum smooth
     14. Buds to 4 cm long
      15. Inflorescences in 7s; adult leaves to 12 cm long ..... **E. eremophila**
      15. Inflorescences in 7s to 11s; adult leaves to 8 cm long ..... **E. tenera**
     14. Buds to 2.5 cm long ..... **E. depauperata**

6. Eucalyptus mimica Brooker & Hopper, *sp. nov.*

Eucalypto steedmanii affinis; arbor "mallet" vel frutex "mallee" ad 5 m altus trunco exili cortice laevi. Folia adulta lincaria, ad 8 x 0.7 cm, olivacea, dense glandulifera. Inflorescentiae axillares, 3-florae; pedunculi erecti. Alabastra pedicellis longis, ad 2.3 x 0.8 cm, longitudinaliter 3 vel 4-costis. Fructus pedicellati quadrati in sectione, ad 1.4 x 0.9 cm.

Typus: 11.3 km along Old Ravensthorpe Road from Newdegate–Lake King road, Western Australia, 24 November 1987, *M.I.H. Brooker* 9811 (*holo:* PERTH; *iso:* AD, CANB, MEL, NSW).

Related to *E. steedmanii* but differing in the smaller buds to 1.8 x 0.8 cm and fruits to 1.3 x 0.9 cm.

Flowering period. Not known.

Etymology. The epithet alludes to the similarity of the new species to *Eucalyptus steedmanii*, from the Latin, *mimicus* (mimicking).

Notes. Eucalyptus mimica is related to *E. steedmanii*, which differs in its larger buds to 3.3 x 1.3 cm and fruit to 2.2 x 1.7 cm. *E. steedmanii* is commonly found on low ironstone hills whereas *E. mimica* occurs either in saline habitats or in sandy loam soils. Two subspecies are recognised for *E. mimica*.

6a. Eucalyptus mimica Brooker & Hopper subsp. **mimica**

Mallee with grey-green over coppery smooth bark. *Buds* with free sepals. (Figure 5A)

Other specimens examined. WESTERN AUSTRALIA: 11 km from Newdegate–Lake King road on Old Ravensthorpe Rd, 17 Dec. 1987, *M.I.H. Brooker* 9838 (AD, CANB, MEL, NSW, PERTH); between Lake Grace and Karlgarin, Feb. 1965, *C.A. Gardner s.n.* (PERTH); ± 7 miles [11 km] SE of Newdegate, 4 Nov. 1965, *A.S.George* 7299 (PERTH); 23 km E of Newdegate on Lake King road, 14 Sep. 1989, *A. Napier* 304 & *A. Kelly* (PERTH); 4 miles [6 km] S of Newdegate, 21 July 1970, *K.R. Newbey* 3217 (CANB, NSW, PERTH); 16 miles [26 km] E of Pingrup, 6 m W of Greenhills soak, Feb. 1953, *D. Serventy* 183 (CANB, MEL, PERTH); W edge of Lake King, 10 Nov. 1983, *P.S. Short* 2356 & *L. Haegi* (AD, MEL, PERTH); 17.8 km SE from Newdegate on Old Ravensthorpe Rd, 23 Oct. 1992, *P.J. White* 397 (PERTH).

Distribution and habitat. Western Australia: from east of Pingrup to south of Newdegate, occupying saline sites. (Figure 2C)

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. *Eucalyptus mimica* subsp. *mimica* is only known from road verges and private land in a small portion of the wheatbelt.

6b. Eucalyptus mimica subsp. **continens** Brooker & Hopper, *subsp. nov.*

A subspecie typica habitu "mallet", trunco exili, cortice atroschistacea, operculo exteriore persistenti et habitatione non salino differt.

Typus: 11 km south along Lockhardt Rd from Magenta Rd, Western Australia, 17 December 1987, *M.I.H. Brooker* 9841 (*holo:* PERTH; *iso:* AD, CANB, MEL, NSW).

Mallet with dark grey bark. *Buds* with persistent outer operculum. (Figure 5B)

Other specimens examined. WESTERN AUSTRALIA: 8 miles [13 km] S of Newdegate, 1952, *G.E. Brockway* 4 (PERTH); 11 km S along Lockhart Rd from Magenta Rd, S of Newdegate, 27 Nov. 1991, *M.I.H. Brooker* 10925 (AD, CANB, NSW, PERTH); 12.1 km N of Ryans Rd on Lockhart Rd, 7 Sep. 1988, *K.D. Hill* 3138 (PERTH); 1/3 mile [0.5 km] SW of Sullivan Soak, Feb. 1953, *D.L. Serventy* 229 (PERTH).

Distribution and habitat. Known only from the type locality and nearby areas of Western Australia, occurring in non-saline, sandy loam soils. (Figure 2C)

Figure 5. Buds and fruits. A – *E. mimica* subsp. *mimica* (*Brooker* 9811); B – *E. mimica* subsp. *continens* (*Brooker* 9841); C – *E. incerata* (*Hill* 627).

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. *Eucalyptus mimica* subsp. *continens* is somewhat rare but is probably secure provided fire frequencies are managed to ensure that adequate canopy-stored seed is present on this fire-sensitive obligate-seeder species.

Etymology. From the Latin, *continens* (retaining), alluding to the retention of the outer operculum until flowering.

Notes. Differs from the typical subspecies by the mallet habit, dark grey bark, persistent outer operculum and the habitat of non-saline, sandy loam soils.

The retention of the intact outer operculum until late in bud development is an attribute unique in Western Australian members of *E.* subgenus *Symphyomyrtus* except for the unrelated box species, *E. petraea* D.J. Carr & S.G.M. Carr.

7. Eucalyptus incerata Brooker & Hopper, *sp. nov.*

Frutex "mallee" *Eucalypto eremophilae* (Diels) Maiden affinis a qua ramulis alabastris fructibusque valde glaucis, alabastris robustioribus, et fructibus leviter costatis differt; a *E. tephrocłada* glaucedine majore, alabastris minoribus in quoque inflorescentia, et alabastris fructibusque majoribus differt.

Typus: 16.1 km north of Hyden–Norseman track on Mt Day road, 32°04'S, 121°02'E, Western Australia, 7 November 1983, *M.I.H. Brooker* 8358, *S.D. Hopper, L.A.S. Johnson & D.F. Blaxell* (*holo:* PERTH; *iso:* AD, CANB, MEL, NSW).

Mallee with affinity to *Eucalyptus eremophila* (Diels) Maiden but differing in the strongly glaucous branchlets, buds and fruit, more robust buds, and the slightly ribbed fruit; from *E. tephrocłada* it differs by more glaucescence, usually fewer buds in the inflorescence, and larger buds and fruits. (Figure 5C).

Other specimens examined. WESTERN AUSTRALIA: 17 km E of grid in rabbit proof fence E of Hyden, 32°25'S, 119°22'E, 9 Aug. 1984, *M.I.H. Brooker* 8621 (AD, CANB, MEL, NSW, PERTH); 603 mile peg between Cross Roads and Marvel Loch, 8 Dec. 1968, *S. Chambers* 188 (PERTH); 16 km E of Rabbit Proof Fence, E of Hyden, 13 Aug. 1965, *C.A. Gardner* 16112 (PERTH); Bremer Range, *c.* 8.9 km SE of Hill 495, 22 Sep. 1994, *N. Gibson & M. Lyons* 1666 (PERTH); 15.8 km N of Hyden–Norseman track on Mt Day track turning off 123.0 km W of Norseman–Coolgardie road, 32°04'S 120°26'E, 7 Nov. 1983, *K. Hill* 627, *L. Johnson, D. Blaxell, I. Brooker & S. Hopper* (CANB, NSW, PERTH); 97.5 km E of Hyden on Hyden–Norseman track, 17 May 1988, *L.A.S. Johnson* 9104 & *M. Johnson* (CANB, NSW, PERTH); 6 km N of Mt Day, 122 km WNW of Norseman, 32°05'S, 120°30'E, 7 Nov. 1983, *S.D. Hopper* 3583 (PERTH); 5 miles [8 km] N on Mt Day Road, 27 Oct. 1966, *A. Kessell* 491 (CANB, PERTH); area S of Marvel Loch, 15 Sep. 1966, *A Kessell* 494 (PERTH); on the Mt Holland–Southern Cross road, Sep. 1967, *W. Rogerson* 345 (PERTH).

Distribution and habitat. Occurs in mallee scrub between Hyden, Norseman and Coolgardie, Western Australia. (Figure 6A)

Flowering period. October to December.

Etymology. The name refers to the white waxy deposit on the branchlets, buds and fruit (Latin, *inceratus* – covered with wax).

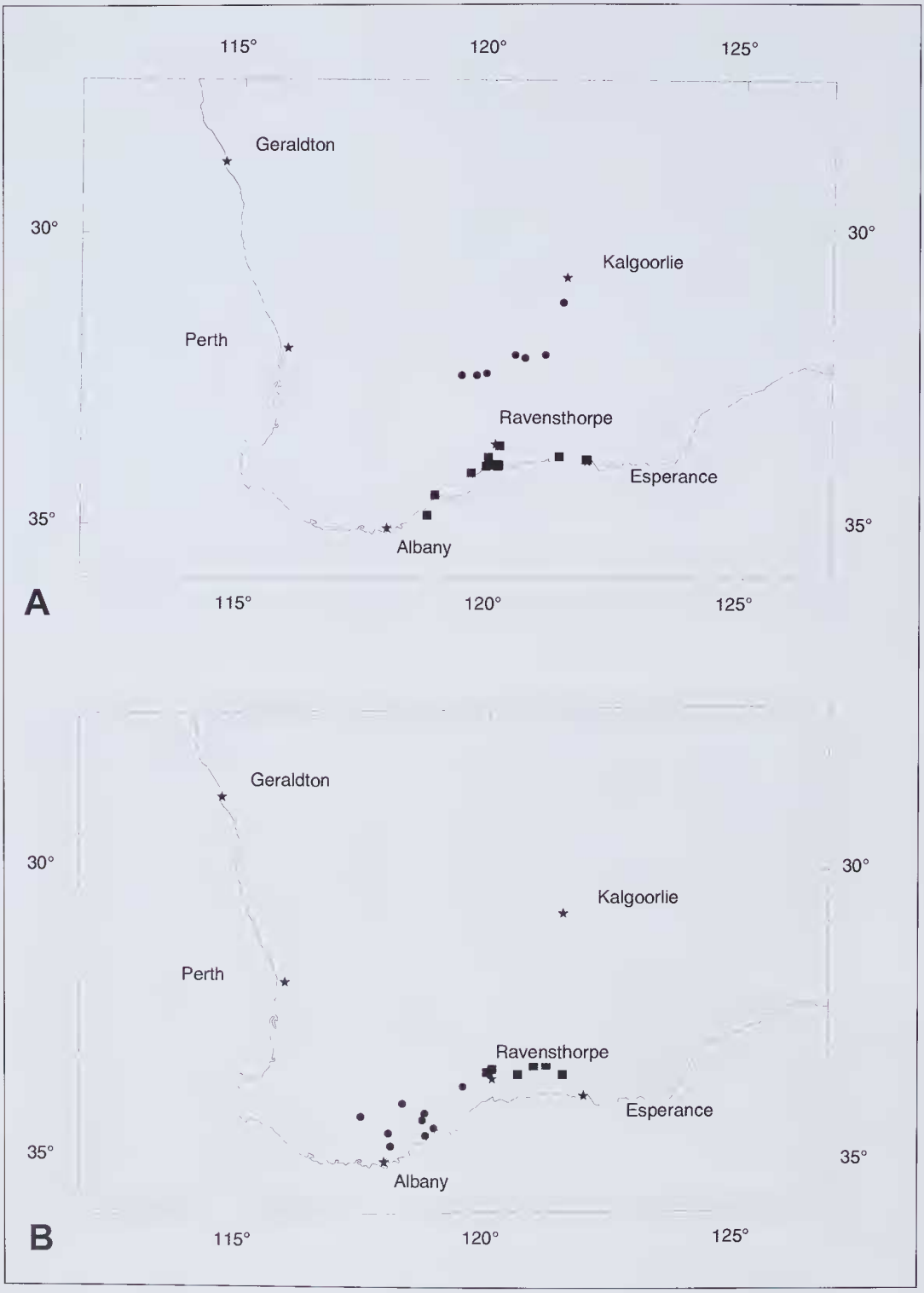

Figure 6. Distribution maps. A – *E. incerata* ● and *E. utilis* ■; B – *E. astringens* subsp. *redacta* ● and *E. platypus* subsp. *congregata* ■.

Notes. Eucalyptus incerata occurs within the range of the widely distributed *E. eremophila* which extends from the Lake Chinocup area to east of Esperance and inland to the Great Victoria Desert. Hill & Johnson (1992) published several other new taxa related to *E. eremophila* and showed the distributional relationships of these parapatric and allopatric taxa, including the then unpublished *E. incerata*. It is likely that clines or intergrades between all relevant taxa occur where the taxa are geographically close.

Eucalyptus incerata differs most noticeably from the related species in the whole glaucous aspect of the mallees, and particularly its glaucous branchlets, buds and/or fruits and its more robust buds and fruit. It is more strongly glaucous and has larger buds and fruits than *E. tephroclada*. *E. incerata* is consistently 7-budded while *E. tephroclada* consistently has more than 7 buds. Specimens of *E. incerata* with the largest fruits often have slight vertical ribbing on the walls of the hypanthium.

8. Eucalyptus utilis Brooker & Hopper, *sp. nov.*

[*Eucalyptus platypus* var. *heterophylla auct. mult. non* Blakely, e.g. Chippendale (1988).]

Arbor "mallet" vel frutex "mallee" cortice laevi cinereo vel cupreo. Folia adulta breviter petiolata, alternantia, elliptica vel late lanceolata, ad 9 x 3 cm concoloria, viridia vel olivacea, nitentia; nervus intramarginalis distincte separatus ab margine folii, reticulum sparsum et glandulae numerosissimae. Inflorescentiae axillares, non ramosae, 7-florae, pedunculi erecti, complanati, ad 2.5 cm longi. Alabastra breviter pedicellata, fusiformia, ad 2.6 x 0.6 cm. Fructus sessiles vel breviter pedicellati plus minusve obconici, ad 1 x 1 cm.

Typus: Hopetoun, Western Australia, 19 October 1964, *C.A. Gardner* 14888 (*holo:* PERTH).

Mallet or *mallee* to 7 m tall with grey over coppery smooth bark. *Seedling leaves* alternate, petiolate, ovate, to 5 x 4 cm, green, scabrid. *Adult leaves* alternate, shortly petiolate, elliptical to broadly lanceolate, to 9 x 3 cm, concolorous, green to olive-green, glossy; intramarginal vein well removed from leaf edge; reticulation sparse, with very numerous oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncle erect, flattened, to 2.5 cm long. *Buds* shortly pedicellate, fusiform, to 2.6 x 0.6 cm. *Fruit* sessile to shortly pedicellate, more or less obconical, to 1 x 1 cm. (Figure 7A)

Other specimens examined. WESTERN AUSTRALIA: Hopetoun, Mar. 1969, *L. Allan* 846 (PERTH); Esperance, 26 Oct. 1963, *T.E.H. Aplin* 2637 (PERTH); Hopetoun plains, 8 Nov. 1952, *P.H. Barrett* 5 (PERTH); 15 miles [24 km] N of Ravensthorpe, 6 Nov. 1952, *P.H. Barrett* 22 (PERTH); 4 mile beach, Hopetoun, 31 Oct. 1962, *J.S. Beard* 2223 (PERTH); Pallinup River, Jan. 1964, *G.E. Brockway* 7483/63 (PERTH); just E of Hopetoun, Feb. 1965, *G. Brockway* s.n. (PERTH); Beaufort Inlet, Millers Point Rd, 34°28'S, 118°51'E, 19 Feb. 1986, *M.I.H. Brooker* 9179 (AD, CANB, MEL, NSW, PERTH); 2 miles [3 km] W of Esperance, 25 Mar. 1968, *G.M. Chippendale* 410 (CANB, PERTH); Fitzgerald River National Park, Hamersley River estuary, NE corner, 33°37'S, 119°55'E, 11 Jan. 1979, *M.D. Crisp* 5039 (CBG, NSW, PERTH); East Mt Barren–Hopetoun, 10 Jan. 1969, *H. Demarz* D1075 (PERTH); Middle Island, 9 Jan. 1973, *M.C. Ellis* 9292 (PERTH); Hopetoun, 12 May 1924, *C.A. Gardner* 2159 (PERTH); S of Kundip, Jan. 1935, *C.A. Gardner s.n.* (PERTH); Hopetoun, 29 Aug. 1963, *C.A. Gardner* 14044 (PERTH); Culham Inlet, 18 Oct. 1964, *C.A. Gardner* 14863 (PERTH); Culham Inlet, 1 Feb. 1960, *A.S. George* 607 (PERTH); near Cape Irby, 29 Mar. 1964, *A.S. George* 6146 (PERTH); 3.2 km E of East Mt Barren, 29 Oct. 1975, *J.W. Green* 4576 (PERTH); end of Millers Point Rd, Beaufort Inlet, 13 May 1982, *G.J.Keighery* 4860 (PERTH); Bremer Bay area, Aug. 1971, *A. Kessell* 965 (PERTH); Barker

Inlet, between Hopetoun and Esperance, 3 Nov. 1962, *M.E. Phillips s.n.* (CBG 021859 in CANB); Mondrain Island, Recherche Archipelago, 9 Feb. 1960, *R.D. Royce* 6222 (PERTH); Hopetoun, 24 Oct. 1982, *A. Strid* 2126 (PERTH); near centre Middle Island, Recherche Archipelago, 34°06'S, 123°10'E, 21 Nov. 1973, *A.S. Weston* 8859 & *M.E. Trudgen* (PERTH); Middle Island, 7 Nov. 1978, *A.S. Weston* 10752 (PERTH); Dempster Head, Esperance, 21 Jan. 1944, *H.M. Wilson* 79 (PERTH).

Distribution and habitat. Occurs in Western Australia from Beaufort Inlet east to Esperance, particularly on coastal sands. (Figure 6A)

Flowering period. December to January.

Etymology. From the Latin, *utilis* (useful), alluding to its widespread cultivation in Perth.

Notes. Inspection of the holotype of *Eucalyptus platypus* var. *heterophylla* in NSW (near Ongerup, Western Australia, 30 May 1917, *F. Stoward s.n.*) by one of us (SDH) showed that this specimen was morphologically intermediate between the locally abundant *E. platypus* subsp. *platypus* and *E.spathulata* and therefore almost certainly a hybrid between those two taxa. Populations that have been attributed for many years to *E. platypus* var. *heterophylla* are not known to occur anywhere near where the type was collected. They constitute the distinct taxon treated here as *E. utilis*, which is particularly well known on the coastal dunes between East Mt Barren and Hopetoun. Robert Brown first collected *E. utilis* from Lucky Bay in January 1802, using the manuscript name *E. linopoda* on his specimen labels.

9. Eucalyptus platypus subsp. **congregata** Brooker & Hopper, *subsp. nov.*

A subspecie typica foliis ellipticis et pedunculo constanter elongato differt.

Typus: Neds Corner Rd, south of Grass Patch Rd intersection, Western Australia, 17 September 1999, *M.I.H. Brooker* 13029 & *A.V. Slee* (*holo:* CANB; *iso:* AD, PERTH)

Differs from the typical subspecies in the elliptical leaves and the consistently elongated peduncle. (Figure 7B)

Other specimens examined. WESTERN AUSTRALIA: 12.3 miles [20 km] S of Salmon Gums, 15 Feb. 1970, *M.I.H. Brooker* 2499 (CANB, MEL, NSW, PERTH); 6.4 km from highway W on Borden–Bremer Bay road, 25 Nov. 1989, *M.I.H. Brooker* 9820 (CANB, PERTH); corner of Robins and Speddingup West Rd, 7 Feb. 1989, *M.I.H. Brooker* 10164 (AD, CANB, MEL, NSW, PERTH); 477 mile peg on Norseman–Salmon Gums road, 29 Mar. 1968, *S.G.M. Carr* 617 (PERTH); near roadside N of Location 1153, *c.* 53 km NNW of the coast at Stokes Inlet, 15 Oct. 1968, *Hj. Eichler* 20247 (AD, CANB); 24 km NE of Fitzgerald on Fitzgerald Rd, 29 Nov. 1983, *D.B. Foreman* 1339 (CANB, MEL, NSW, PERTH); 600 m S of SW corner of Moolyall Rocks Nature Reserve, 11 Mar. 1988, *S.D. Hopper* 6340, (CANB, PERTH); Kundip, 22 Apr. 1953 *R.D. Royce* 4152 (PERTH); West Point Rd between Rawlinson Rd and Oldfield River, 13 Sep. 1999, *A.V. Slee* 4244 (CANB); 14 km from Ravensthorpe towards Lake King township, 10 km N of Lake King turn-off from Ravensthorpe–Albany road, 22 Oct. 1981, *J.G. West* 4600 (CANB, PERTH).

Distribution. Occurs in Western Australia, from the Lake King–Ravensthorpe road eastwards towards Salmon Gums. (Figure 6B)

Flowering period. January to March.

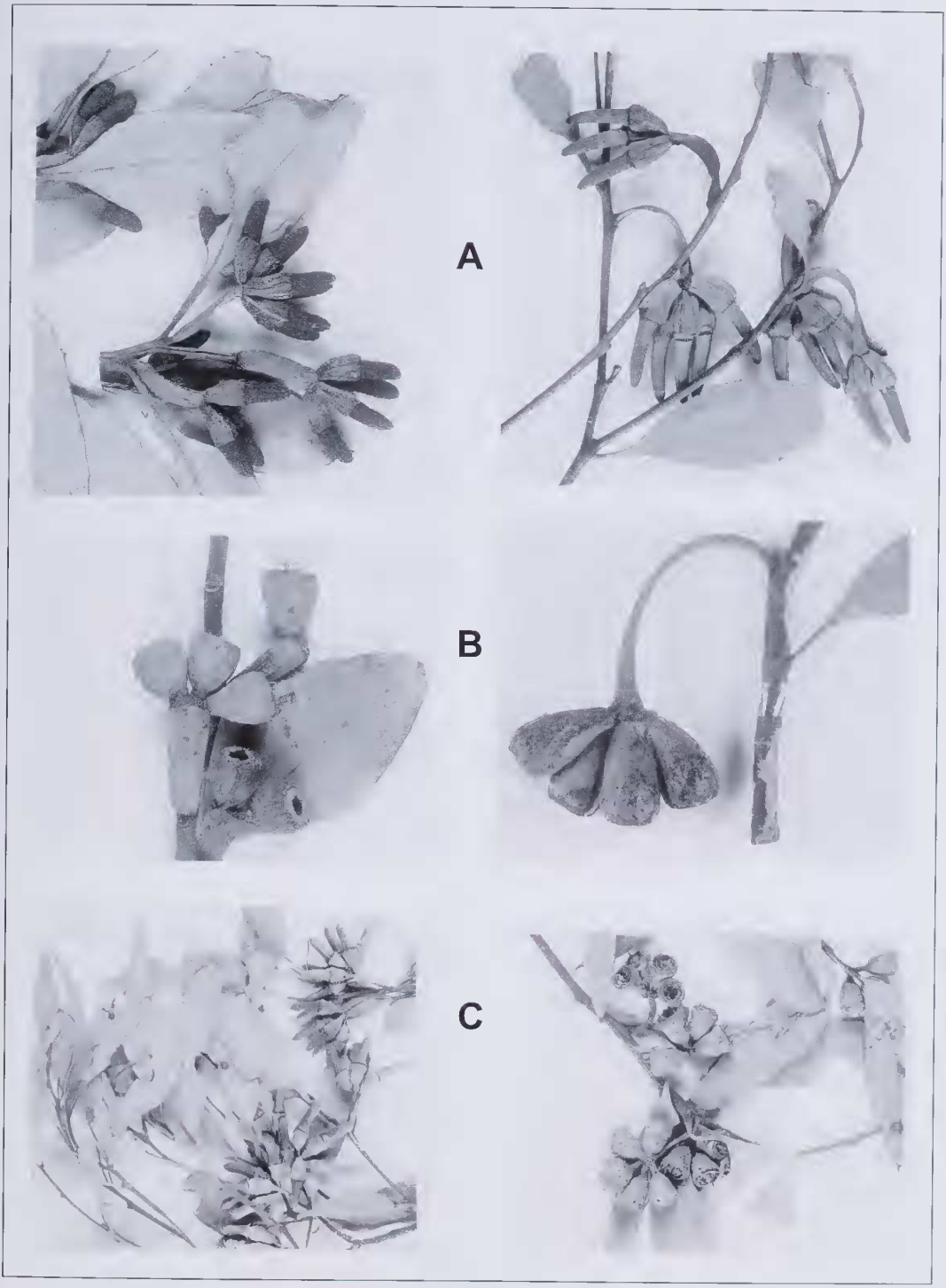

Figure 7. Buds and fruits. A – *E. utilis* (CBG 021859 in CANB); B – *E. platypus* subsp. *congregata* (*Brooker* 13029); C – *E. astringens* subsp. *redacta* (*Brooker* 13040).

Etymology. The name refers to the dense communities in which it occurs.

Notes. This subspecies occurs in more or less pure marlock stands, similar to the typical subspecies. Inspection of the foliage reveals the distinguishing leaf shape. The long peduncles are not so strongly diagnostic as they can occur in the typical subspecies.

There are stands of marlocks between the Lake King–Ravensthorpe road and Lake Magenta which have affinity with both *E. platypus* subsp. *congregata* and *E. goniocarpa* Johnson & Hill and should be regarded as intermediates.

Eucalyptus subser. **Pedicellatae** Blakely, "Key Eucalypts" 23, 108 (1934). *Type: Eucalyptus astringens* (Maiden) Maiden.

Mallees or *mallets. Pith of branchlets* glandular. *Adult leaves* glossy, green or olive-green, with numerous oil glands, not obscuring the side veins. *Stamens* erect, arising from a narrow staminophore.

Notes. A subseries of nine species, three of which comprise two subspecies. It is equivalent to the informal *Eucalyptus* subser. *Occidentalinae* Pryor & Johnson, "Class. Eucs" (1971).

Key to species and subspecies of *Eucalyptus* subser. *Pedicellatae*

1. Rough bark in mature plants present over part or most of trunk or stems
   2. Peduncles slender, not flattened
      3. Buds < 2.4 cm long; fruit < 0.9 cm long ..... **E. sargentii** subsp. **sargentii**
      3. Buds > 2.4 cm long; fruit > 0.7 cm long ..... **E. sargentii** subsp. **fallens**
   2. Peduncles widening towards top
      4. Fruit campanulate, valves prominent ..... **E. occidentalis**
      4. Fruit cupular, valves enclosed or to rim level ..... **E. aspratilis**
1. Bark smooth, or trunk with partly shed curls of dead bark, otherwise smooth
   5. Mallet
      6. Buds to 2 x 0.6 cm; fruit to 1.2 x 1 cm; trunk with partly shed curls of dead bark, otherwise smooth ..... **E. astringens** subsp. **astringens**
      6. Buds to 1.5 x 0.4 cm; fruit to 0.9 x 0.7 cm; bark smooth .... 10. **E. astringens** subsp. **redacta**
   5. Mallee
      7. Peduncles flattened and widening towards tip
         8. Fruit campanulate
            9. Fruit to 0.6 x 0.8 cm ..... 11a. **E .thamnoides** subsp. **thamnoides**
            9. Fruit to 1.2 x 1 cm ..... 11b. **E. thamnoides** subsp. **megista**
         8. Fruit cylindrical to obconical ..... 12. **E. sporadica**
      7. Peduncles slender, not or scarcely flattened
         10. Buds and fruit prominently ribbed; leaves very glossy, bright green ..... **E. stowardii**
         10. Buds and fruit not or scarcely ribbed; leaves slightly glossy, green, blue-green or olive green
            11. Opercula smooth, pointed at the tip; bark rough at base of larger specimens; on saline soils ..... **E. sargentii** subsp. **fallens**
            11. Opercula slightly ribbed, rounded at the tip; bark smooth; on sandstone, kaolinite or laterite ..... 13. **E. diminuta**

10. Eucalyptus astringens subsp. **redacta** Brooker & Hopper, *subsp. nov.*

A subspecie typica statura inferiore, cortice lacvi, et alabastris fructibusque minoribus differt.

Typus: Wellstead Rd to Cape Riche at the Mt Maxwell (Konkoberup Hill) rubbish tip, Western Australia, *A.V. Slee* 4117 (*holo:* CANB; *iso:* PERTH).

Differs from the typical subspecies by the smaller stature, smooth bark, and smaller buds and fruits. (Figure 7C)

Other specimens examined. WESTERN AUSTRALIA: 1 km S of Pallinup River at Chillinup, 11 Oct. 1984, *B. Briggs* 7880 & *L.A.S. Johnson* (NSW, PERTH); 200 m from N side of Beaufort Inlet, on main road to water, 14 Nov. 1981, *M.I.H. Brooker* 7165 (CANB, PERTH); Beaufort Inlet, track to NW of camping site, 14 Nov. 1981, *M.I.H. Brooker* 7167 (CANB, PERTH); Konkoberup Hill, 34°36'S, 118°44'E, 29 Nov. 1984, *M.I.H. Brooker* 8741 (AD, CANB, MEL, NSW, PERTH); 0.7 km south along Norman Rd from Cowellup Rd, 34°12'S, 118°42'E, 21 Feb. 1985, *M.I.H. Brooker* 8864 (CANB, MEL, NSW, PERTH); Sandalwood Rd, 34°16'S, 118°16'E, 13 Apr. 1985, *M.I.H. Brooker* 8953 (CANB, MEL, NSW, PERTH); W edge of Swan Gully, 8.5 km NNW of Cape Riche, 6 Oct. 1987, *S.D. Hopper* 6192 (PERTH); 8.5 km S along Carlawillup Rd, 34°07'S, 119°03'E, 9 Mar. 1988, *M.I.H. Brooker* 9906 (AD, CANB, MEL, NSW, PERTH); Sandalwood Rd, E of Borden, before Gnowellen Rd, 8 Apr. 1995, *M.I.H. Brooker* 12215 (CANB, PERTH); between Yeriminup Rd and Albany Highway, 8 Apr. 1995, *M.I.H. Brooker* 12221 (CANB, PERTH); 41.6 km W of Ravensthorpe, 29 Aug. 1998, *M.I.H. Brooker* 12918 & *A.V. Slee* (CANB, PERTH); Borden–Bremer road, 9 km W from highway, 19 Aug. 1999, *M.I.H. Brooker* 13040 & *A.V. Slee* (CANB, PERTH); 1 km W of Kamballup, 30 km ENE of Mount Barker, 15 Sept. 1985, *G.J. Keighery & J.J. Alford* 1611 (CANB, PERTH); 2 km N of Borden on Borden road, 23 Oct. 1985, *N. Hoyle* 1126 (CANB, PERTH).

Distribution. Western Australia: from west of the Stirling Range, through the lower Pallinup River area, eastwards to Bremer Bay, including the Stirling Range National Park. (Figure 6B)

Flowering period. August to November.

Etymology. The name refers to the small buds and fruit compared with the typical subspecies (from the Latin, *redactus* – reduced).

Notes. This is one of several taxa that have been incorrectly ascribed to either *E. occidentalis* or typical *E. astringens*, which are distinguished in the subseries by the short, stubby buds and slightly flared fruits. *E. occidentalis* is a basally rough-barked species of seasonally waterlogged sites. By contrast both subspecies of *E. astringens* are confined to well-drained lateritic rises and slopes.

This small, erect mallet may be associated with other mallet species, e.g. *E. newbeyi* D.J. Carr & S.G.M. Carr and *E. melanophitra* Brooker & Hopper, and the mallee, *E. neutra* Nicolle.

11. Eucalyptus thamnoides Brooker & Hopper, *sp. nov.*

Encalypto astringenti affinis a qua habitu fruticoso et habitatione non collinis differt.

Typus: Needilup Rd, 6.8 km south of East Rd, Western Australia, 21 July 1988, *M.I.H. Brooker* 10003 (*holo:* CANB; *iso:* PERTH).

With affinity to *Eucalyptus astringens*, differing by the mallee habit and non-breakaway habitat.

Etymology. From the Greek, *thamnos* (shrub or bush), in reference to the habit compared with the related mallet species, *E. astringens*.

11a. Eucalyptus thamnoides Brooker & Hopper **thamnoides**, *subsp. nov.*

Mallee with fruit to 0.6 x 0.8 cm. (Figure 8A)

Specimens examined. WESTERN AUSTRALIA: 8.4 km S by fire trail from Salt River Rd, SW of Donnelly Peak, Stirling Range, 9 Oct. 1982, *M.I.H. Brooker* 7721 (CANB, PERTH); 3.6 km W of Sanders Rd on Kendenup Rd, 9 June 1983, *M.I.H. Brooker* 8185 (CANB, PERTH); 2 km NW of Kambellup on Woogenillup Rd, 13 Apr. 1985, *M.I.H. Brooker* 8950 (CANB, PERTH); 10–20 km E of Jerramungup, 25 Nov. 1987, *M.I.H. Brooker* 9818 (CANB, PERTH); 8.4 km S along Carlawillup Rd, 9 Mar. 1988, *M.I.H. Brooker* 9906 (CANB, PERTH); 8.2 km WNW of Nyabing, 19 July 1988, *M.I.H. Brooker* 9988 (CANB, PERTH); 1 km from Kambellup (highway) on Woogenillup Rd., 8 Apr. 1995, *M.I.H. Brooker* 12216 (CANB, PERTH); 3 km from Kambellup (highway) on Woogenillup Rd, 8 Apr. 1995, *M.I.H. Brooker* 12217 (CANB, PERTH); 3.7 km W of Sanders Rd on road to Kendenup, 8 Apr. 1995, *M.I.H. Brooker* 12218 (CANB, PERTH); 9.5 km N of Formby South Rd on Chester Pass Rd, Stirling Range National Park, 21 Aug. 1999, *M.I.H. Brooker* 13046 & *A.V. Slee* (CANB, PERTH); 15 km S of Ongerup, Peenebup Creek, 22 Jan. 1980, *M.D. Crisp* 6141, *J. Taylor* and *R. Jackson* (CANB); Gnowangerup at 0.6 km on Tambellup Rd from Jerramungup Rd, 31 Oct. 1988, *L.A.S. Johnson* 9164 & *B.A. Briggs* (CANB, NSW); 1 km E of Warrungup, Stirling Range, 10 May 1982, *G.J. Keighery* 4833 (CANB, PERTH); Kamballup Reserve, SE corner, 27 Feb. 1988, *A. Napier* & *A. Taylor* 208, (CANB, PERTH); Pallinup River area, 20 Apr. 1996, *D. Nicolle* 2243 (AD, CANB, PERTH); 12 miles [19 km] from Gnowangerup, 10 Oct. 1962, *M.E. Phillips* (CBG 021940); *c.* 20 miles [32 km] from Gnowangerup, towards Albany, 10 Oct. 1962, *M.E. Phillips* (CBG 021942) (CANB); 23 miles [37 km] from Gnowangerup, 10 Oct. 1962, *M.E. Phillips s.n.* (CBG 021949) (CANB); 5 miles [8 km] N of Stirling Range, 21 May 1964, *R.D. Royce* 8156 (CANB, PERTH); 20 km [32 km] W of Bremer Bay township, 1 Oct. 1966, *P.G. Wilson* 4332 (CANB, PERTH).

Distribution. Western Australia: from Gnowangerup area to south of the Stirling Range and north-east towards Jerramungup, including the Stirling Range National Park. (Figure 9A)

Flowering period. Not known.

Notes. It is distinguished from the following subspecies by the smaller buds and fruits (to 0.6 x 0.8 cm). The two subspecies bear a parallel relationship in fruit size to the subspecies of *Eucalyptus astringens*. Associated species include several mallees, e.g. *E. falcata* Turcz., *E. phaenophylla* Brooker & Hopper, *E. pluricaulis* Brooker & Hopper subsp. *porphyrea* Brooker & Hopper, *E. uncinata* Turcz., and *E. preissiana* Schauer subsp. *preissiana*.

11b. Eucalyptus thamnoides subsp. **megista** Brooker & Hopper, *subsp. nov.*

A subspecie typica alabastris fructibusque majoribus differt.

Typus: Norman Rd, Corackerup Creek Nature Reserve, east side of road, Western Australia, 8 April 1995, *M.I.H. Brooker* 12212 (*holo:* CANB; *iso:* AD, NSW, PERTH).

Differs from the typical subspecies by the larger buds and fruit (to 1.2 x 1 cm). (Figure 8B)

Figure 8. Buds and fruits. A – *E. thamnoides* subsp. *thamnoides* (*Brooker* 13046); B – *E. thamnoides* subsp. *megista* (*Brooker* 12912).

Specimens examined. WESTERN AUSTRALIA: 5.8 km S of Ongerup, 21 Feb. 1985, *M.I.H. Brooker* 8862 (CANB, PERTH); Narrakine State Forest, O'Neill's Rd, 19 Jun. 1986, *M.I.H. Brooker* 9357 (CANB, PERTH); Newman Block, Chomley Rd, breakaway on S side, 19 Jun. 1986, *M.I.H. Brooker* 9360 (CANB, PERTH); 15.6 km along Brook Rd from highway 1, 18 May 1987, *M.I.H. Brooker* 9641 (CANB, PERTH); 14.8 miles [23.8 km] SSE of Ravensthorpe, 23 Mar. 1968, Ranger's House, Quiss Rd., Fitzgerald River National Park, 25 Nov. 1991, *M.I.H. Brooker* 10921 (AD, CANB, NSW, PERTH); 0.5 km W of Highbury Tavern, 5 Apr. 1995, *M.I.H. Brooker* 12185 (AD, CANB, NSW, PERTH); 110 km from Albany towards Jerramungup, 4.2 km S of Pallinup River, 28 Aug. 1998, *M.I.H. Brooker* 12912 *& A.V. Slee* (CANB,PERTH); 3 miles [6.8 km] N from Cranbrook, 11 Sep. 1947, *N.T. Burbidge* 2468 (CANB); Mt Merrivale (near Esperance), low down mount on W side, around base of rock, 4 Nov. 1968, *E.M. Canning* (CBG 068524) (CANB); *G.M. Chippendale* 417 (CANB, MEL, NSW, PERTH); 2.9 miles [4.7 km] W of Needilup, 27 Mar. 1968, *G.M. Chippendale* 424 (CANB, PERTH); Ravensthorpe Range, 23 Nov. 1994, *D. Nicolle* 1122 (AD, CANB); *c.* 20 miles [32 km] from Gnowangerup, 10 Oct 1962, *M.E. Phillips* (CBG 021942) (CANB); Nature Reserve, Jaloran–Piesseville road, 3.5 km E of junction with Edwards Rd, 3 July 1992, *P. White* 314 (CANB, PERTH); 7 miles [11 km] from Ravensthorpe towards Hopetoun, at junction of minor road near copper mine, 27 Oct. 1968, *J. Wrigley* (CBG 028793) (CANB).

Distribution. Western Australia: from Williams and Cranbrook districts in the west, eastwards to the western end of the Fitzgerald River National Park. (Figure 9A)

Flowering period. Unknown, maybe variable throughout the year.

Etymology. From the Greek, *megistos* (largest), alluding to the size of the fruits compared with the typical subspecies.

Notes. This subspecies occurs on plains and low rises, not lateritic breakaways. The soils may be red-brown sandy clays or sandy gravel. There is a great variety of associated species, including, *Eucalyptus incrassata* Labill., *E. pluricaulis* Brooker & Hopper subsp. *pluricaulis*, *E. falcata*, *E. wandoo* Blakely, *E. redunca* Schauer, *E. phaenophylla* Brooker & Hopper and *E. uncinata*.

12. Eucalyptus sporadica Brooker & Hopper, *sp. nov.*

Frutex "mallee" cortice laevi. Folia plantularum petiolata, alternantia, ovata vel lanceolata, ad 9 x 3 cm. Folia adulta petiolata, alternantia, lanceolata vel falcata, 5–9 x 1–1.8 cm, concoloria, nitentia, viridia. Inflorescentiae axillares, non ramosae, 7-florae; pedunculi deflexi, complanati, 0.8–2 cm longi. Alabastra pedicellata, elongata, 1.7–2.5 x 0.4–0.5 cm, operculo cornuto. Fructus pedicellati cylindrici vel leviter campanulati, 0.8–1.5 x 0.7–1.2 cm, disco descendenti et valvis exsertis.

Typus: 3.6 km N of Burngup, Western Australia, 8 September 1984, *M.I.H. Brooker* 8684 (*holo:* CANB; *iso:* AD, MEL, NSW, PERTH).

Mallee to 4 m tall with red-brown, greenish grey, grey, or silvery white smooth bark. *Juvenile leaves* alternate, petiolate, ovate to lanceolate, to 9 x 3 cm, light green to blue-green. *Adult leaves* alternate, petiolate, lanceolate or falcate, 5–9 x 1–1.8 cm concolorous, glossy, green; reticulation moderately dense, with numerous large island and intersectional oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncle down-turned, flattened, 0.8–2 cm long. *Buds* pedicellate, elongated, 1.7–2.5 x 0.4–0.5 cm, scar obscure; operculum horn-shaped. *Fruit* pedicellate, cylindrical to slightly campanulate, 0.8–1.5 x 0.7–1.2 cm; rim thin; disc descending; valves 3 or 4, exserted. (Figure 10A)

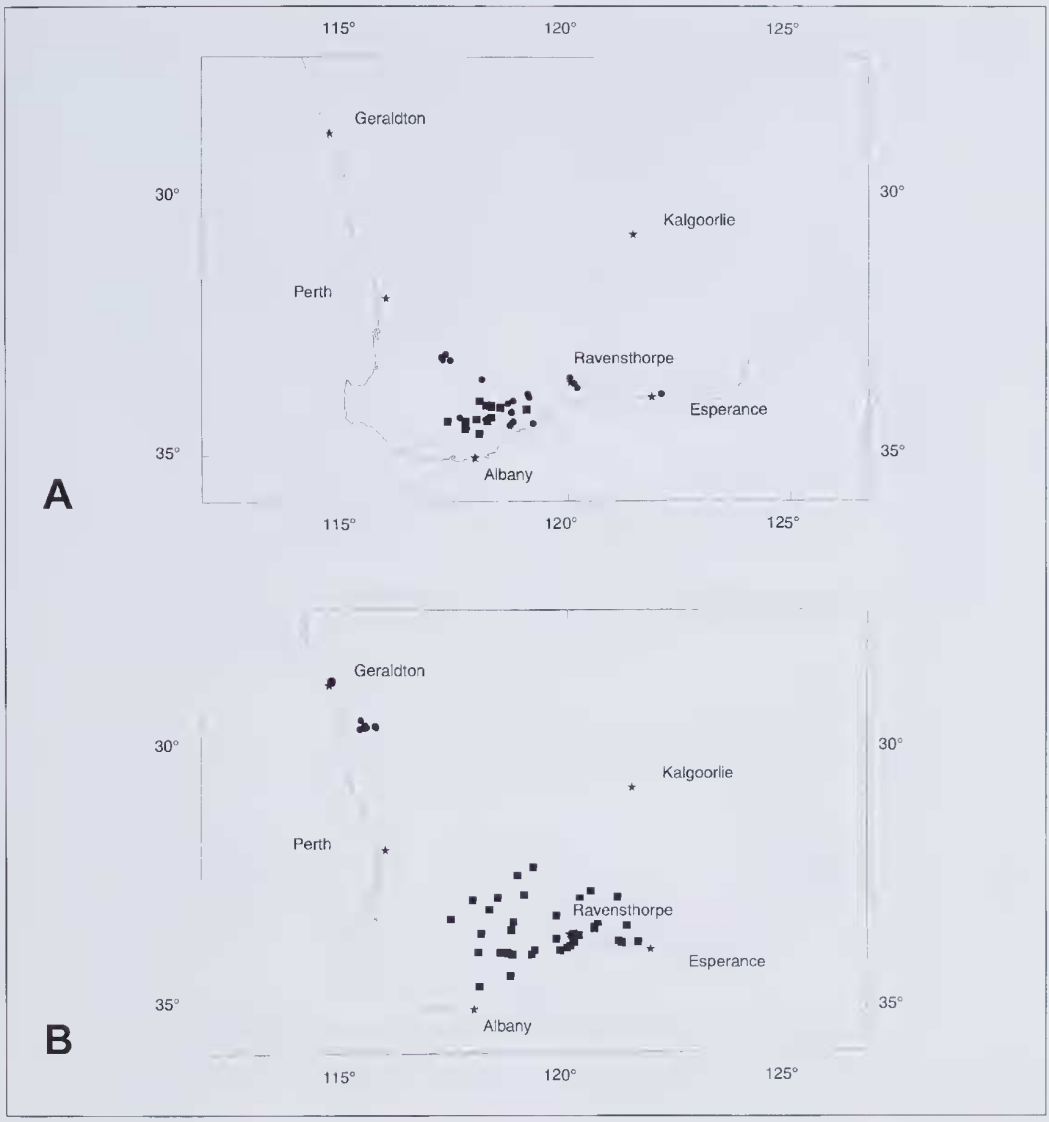

Figure 9. Distribution maps. A – *E. thamnoides* subsp. *megista* ● and *E. thamnoides* subsp. *thamnoides* ■; B – *E. diminuta* ● and *E. sporadica* ■.

Other specimens examined. WESTERN AUSTRALIA: Tarin Rock, opposite siding, 24 Sep. 1974, *T.E.H. Aplin* 6021 (CANB, PERTH); 20.6 km E of Ravensthorpe on Hwy 1, 26 Oct. 1985, *D.J. Bedford* 566 (CANB, NSW, PERTH); *c.* 5 miles [8 km] S of Kundip, towards Hopetoun, 7 Apr. 1974, *M.I.H. Brooker* 4458 (CANB,PERTH); Peak Charles, 2 May 1982, *M.I.H. Brooker* 7505 (CANB, PERTH); Ravensthorpe Range, NW of Mt Desmond, 13 Nov. 1981, *M.I.H. Brooker* 7143 (CANB, NSW, PERTH); Hamersley River crossing, Fitzgerald River National Park, 18 Dec. 1984, *M.I.H. Brooker* 8759 (CANB, PERTH); Frank Hann National Park, 8 Aug. 1978, *D. Butcher* 327 (CANB, PERTH); 20 miles [32 km] W from Esperance–Norseman road towards Lake King, 23 Sep. 1978, *R.J. Cranfield* 761 (CANB, PERTH); Frank Hann National Park, 8 Aug. 1978, *D. Monk* 337 (CANB, PERTH); NW base of Annie Peak, 30 May 1970, *K. Newbey* 3168 (CANB, PERTH); 3 km along Northern Fireline from Quiss Rd, Fitzgerald River National Park, 4 May 1999, *A. Slee* 4124 (CANB, PERTH).

Distribution. Widespread in the south-eastern part of the southern wheatbelt of Western Australia, from Lake Grace and the Fitzgerald River National Park east towards Peak Charles. (Figure 9B)

Flowering period. Variable, maybe throughout the year.

Etymology. From the Latin, *sporadicus* (sporadic) in reference to its widespread and scattered distribution.

Notes. Eucalyptus sporadica has been collected widely in the area of occurrence. It has been confused with *E. eremophila* of *E.* subser. *Abundae* but it is readily distinguished by the non-glazed leaf surfaces and the narrow staminophore. It is probably closest to *E. aspratilis* which is distinguished by rough bark and the somewhat larger, straight-sided fruit.

13. Eucalyptus diminuta Brooker & Hopper, *sp. nov.*

Frutex "mallee" *Eucalypto stowardii* Maiden affinis a qua cortice interdum cupreo, foliis adultis parvioribus (6–8 x 0.7–1.5 cm) minus nitentibusque, alabastris (1.8–2.5 x 0.5–0.7 cm) fructibusque (1–1.4 x 0.8–1.1 cm) parvioribus minus costatibusque differt.

Typus: Yuna road, 28°42S, 114°40'E, Western Australia, 4 November 1985, *M.I.H. Brooker* 9061 (*holo:* PERTH; *iso*: CANB, NSW).

Mallee with affinity to *Eucalyptus stowardii*, from which it differs in the bark being at times coppery, the smaller, less glossy adult leaves, and smaller, less ribbed buds and fruit. (Figure 10B)

Other specimens examined. WESTERN AUSTRALIA: 1 km E of Mindaloo Beacon, 24°34'S, 115°25'E, 27 May 1983, *M.I.H. Brooker* 8141 (CANB, PERTH); 7.7 km from Geraldton–Northampton road on Yuna road, 28°42'S, 114°42'E, 30 Oct. 1984, *M.I.H. Brooker* 8721 (CANB, PERTH); pass NE of Geraldton on Yuna road, 28°42'S, 114°40'E, 11 June 1985, *M.I.H. Brooker* 9038 (CANB, PERTH); Yandanooka Nature Reserve, 13 Mar. 1986, *M.I.H. Brooker* 9204 *& S.D. Hopper* (CANB, PERTH, NSW, MEL); 13.1 km SW of Three Springs on Encabba road, 29°34'S, 115°39'E, 21 Nov. 1986, *M.I.H. Brooker* 9554 (AD, CANB, MEL, NSW, PERTH); W side of Mindaloo Beacon Hill, 21 Apr. 1998, *M.I.H. Brooker* 9938 (CANB); 9 miles [14.5 km] NE of Geraldton on Yuna road, 16 Mar. 1968, *G.M. Chippendale* 321 (CANB, PERTH).

Distribution. Occurs in Western Australia, recorded from Moresby Range, north-east of Geraldton along road to Yuna, near Mindaloo Beacon and in the Yandanooka Nature Reserve. (Figure 9B)

Flowering period. October to December.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. *Eucalyptus diminuta* is numerically rare and known from only two localities, but is secure in at least one nature reserve.

Etymology. The name alludes to the smaller leaves and less ribbed buds and fruit than those of *Eucalyptus stowardii* (Latin, *diminutus* – diminished).

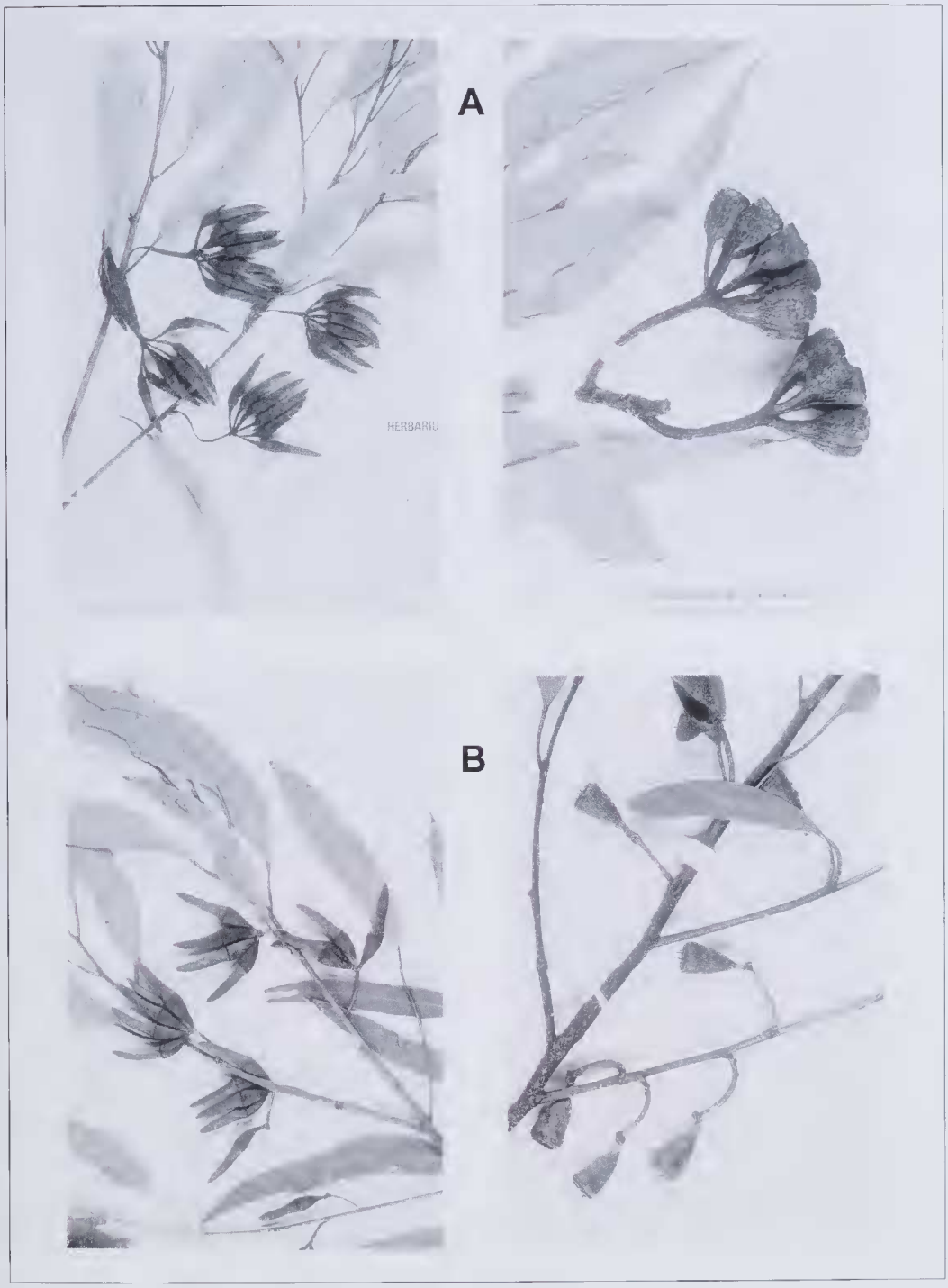

Figure 10. Buds and fruits. A – *E. sporadica* (*Brooker* 4458); B – *E. diminuta* (*Brooker* 9938).

Notes. Eucalyptus diminuta has been confused with *E. stowardii* but differs notably in its habitat of sandstone, laterite or kaolinite rubble associated with hills and breakaways. *E. stowardii* occurs mainly on sands, although it occurs on decomposing stony granite rises north-west of Merredin. *E. stowardii* differs markedly from *E. diminuta* in its larger, very glossy leaves, and the much more strongly ribbed buds. The two species, with *E. sargentii*, are notable among *E.* ser. *Erectae* by the slender, non-flattened peduncles.

Eucalyptus diminuta differs from *E. sporadica* by the terete peduncles, shorter, slightly ribbed, obtuse opercula and smaller, usually obconic fruit. It differs from *E. sargentii* subsp. *fallens* by the consistently smooth bark, slightly ribbed obtuse opercula, and occurrence on hills and breakaways.

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References

Beard, J.S. (1976). A progeny trial to obtain evidence of hybridity in two taxa of *Eucalyptus*. *Journal of the Royal Society of Western Australia* 56: 78–79.

Bentham, G. (1867). "Flora Australiensis." Vol. 3. (L. Reeve & Co.: London.)

Blakely, W.F. (1934). "A Key to the Eucalypts." (The Worker Trustees: Sydney.)

Brooker, M.I.H. (2000). A new classification of the genus *Eucalyptus* (Myrtaceae). *Australian Systematic Botany* 13: 79–148.

Brooker, M.I.H. & Hopper, S.D. (1991). A taxonomic revision of *Eucalyptus wandoo*, *E. redunca*, and allied species (*Eucalyptus* series *Levispermae* Maiden – Myrtaceae) in Western Australia. *Nuytsia* 7: 1–189.

Brooker, M.I.H. & Kleinig, D.A. (1990). "Field Guide to Eucalypts." Vol. 2. (Inkata Press: Melbourne.)

Carr, D.J. & Carr, S.G.M. (1980). The *Lehmannianae*: a natural group of Western Australian eucalypts. *Australian Journal of Botany* 28: 523–550.

Chippendale, G.M. (1988). *Eucalyptus, Angophora* (Myrtaceae). "Flora of Australia." Vol. 19. (Australian Government Publishing Service: Canberra.)

Hall, C. (1914). The evolution of the eucalypts in relation to the cotyledons and seedlings. *Proceedings of the Linnean Society of New South Wales*. 39: 473–532.

Hill, K.D. & Johnson, L.A.S. (1992). Systematic studies in the eucalypts. 5. New taxa and combinations in *Eucalyptus* (Myrtaceae) in Western Australia. *Telopea* 4: 561–634.

Johnson, L.A.S. & Hill, K.D. (1991). Systematic studies in the eucalypts. 2. A revision of the gimlets and related species: *Eucalyptus* extracodocal series *Salubres* and *Annulatae* (Myrtaceae). *Telopea* 4: 201–222.

Kelly, A.E., Napier, A.C. & Hopper, S.D. (1995). Survey or rare and poorly known eucalypts of Western Australia. *CALMScience* Supplement 2: 1–206.

Maiden, J.H. (1929). "A Critical Revision of the Genus *Eucalyptus*." Vol. 7. (Government Printer: Sydney.)

Maiden, J.H. (1933). "A Critical Revision of the Genus *Eucalyptus*." Vol. 8. (Government Printer: Sydney.)

Pryor, L.D. & Johnson, L.A.S. (1971). "A Classification of the Eucalypts." (Australian National University: Canberra.)